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The Marine Observer

A quarterly journal of Maritime Meteorology

Volume XXII No. 156

April, 1952

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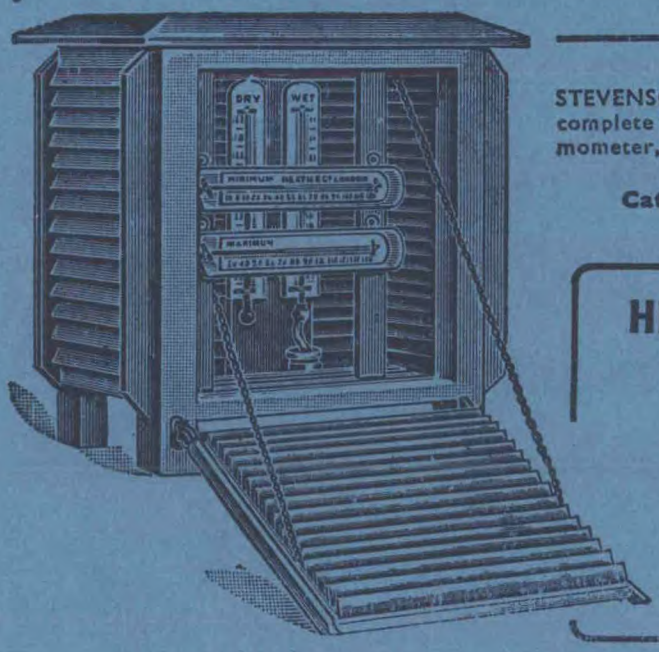

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King George VI

M.O. 556 AIR MINISTRY

THE MARINE OBSERVER

A QUARTERLY JOURNAL OF MARITIME METEOROLOGY PREPARED BY THE MARINE BRANCH OF THE METEOROLOGICAL OFFICE

VOL. XXII No. 156 APRIL, 1952

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Frontispiece. Photo by Dorothy Wilding, London

Letters to the editor, and books for review, should be sent to The Editor, " The Marine Observer," Meteorological Office, Headstone Drive, Harrow, Middlesex

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Editorial

The passing, on 6th February, 1952, of His Majesty King George VI, Master of The Merchant Navy and Fishing Fleets, and Admiral of The Honourable Company of Master Mariners, is mourned by all voluntary observers in ships of The British Commonwealth.

"For He maketh the storm to cease: so that the waves thereof are still. Then are they glad, because they are at rest." *Psalm 107.*

As far as the ordinary individual is concerned the prime importance of any science lies in its application to the comfort and well-being of that individual, and with the well-being of the individual is linked the economics and industrial efficiency as well as the strength of his nation.

The advent of the atom bomb and other horrors of modern warfare makes one wonder where scientific invention is leading mankind, and if the misuse of science by some Machiavellian development will eventually destroy our present civilisation, which has taken so long to create and which has so much of beauty in it. But in the balance, if we pause to reflect, it does seem that mankind owes a debt of gratitude to science in general, for it has done much more to benefit than to harm us.

It is interesting to reflect how much of the work of the pioneers in any branch of science is done with no specific material object in view, but merely that very human urge of " trying to find out why ". Newton with his famous apple, Torricelli with the barometer, Hertz with electro-magnetic waves, or Rutherford with his investigation into atomic structure were probably not considering any economic or commercial application when they started their research work—they were merely seekers after the truth. It is only when a particular line of science " gets going ", as it were, that its application to some economic or other useful purpose becomes clear. At present, for example, a group of scientists are engaged upon a study of planetary radio waves, while others are studying ozone concentrations in the upper atmosphere. The ordinary layman finds it extremely difficult to think what possible application such studies could have on his daily life. Oceanographers seem to spend an extraordinary amount of time and energy getting cores of the bottom sediments of the ocean and in studying such subjects as light penetration into the ocean. When the Swedish oceanographic ship *Albatross* returned from her round-the-world voyage with a mass of observations which will take many years to work out, somebody asked Dr. Hans Petterssen, the leader, what the economic advantages of his investigations would be. He replied: " I have no specific idea—we are merely a party of scientists trying to learn something more about what takes place in and under the oceans ".

So long as men feel like that and cheerfully put up with the discomfort of expeditions to Everest and to the Antarctic, go up in the air in balloons or under the sea in bathyspheres, merely to learn something more about Nature and for no material gain, then there is hope for humanity.

In the relatively infant world of meteorology we are only really beginning to see its application to industry and other economic interests, and, in this world of enormous population and increasing competition, economic aspects are vital. As a science, meteorology has rather an unusual history. Although Aristotle, and the

early Egyptians before him, took an interest in the subject and wrote about it, up to the early nineteenth century it was only by seamen and those interested in the sea that anything specific was done to increase our knowledge of meteorology. Yet it must have been fairly obvious to everybody that there is little that affects our lives so intimately as the weather—but of course it affected the lives of seamen more than anybody. It seems right, therefore, that it should have been a seaman, in the person of Maury, who first started us off on international meteorology in 1854—but it was the economic aspect of sailing-ship operation that was the spur.

It was not until the aircraft came into the picture that Meteorological Services started the phenomenal expansion which we see today, and with the expansion of meteorological services for aviation we have seen the simultaneous expansion of such services for other purposes. The research into the multitudinous meteorological problems which have been inspired by aviation requirements, has encouraged development in other directions, and various industries have been made aware of the economic advantages of meteorological statistics for countless purposes. The Meteorological Services of most countries with a seaboard have at least a few members with a maritime background on their staff, and they all cater for shipping by providing forecasts and other services. Nearly all Meteorological Services have departments which specialise in agriculture and hydrology and in climatology for general purposes. The importance of meteorology from an agricultural point of view is fairly obvious, and, in fact, if more interest had been taken in soil physics some years ago the tragedy of the dust bowls in the United States might have been avoided. The present fertility of Israel probably owes a lot to applied meteorology, and in this rather hungry world there is little doubt that agriculture will always make an important claim on meteorological research. The relationship between meteorology and hydrology is also fairly obvious, and the present interest in water power in various parts of the world probably gives it a stimulus. But it is in the general application of climatology and forecasting to everyday life that more and more attention is being paid at present. The enquiries which the climatologists and forecasters of almost any Meteorological Service receive nowadays are incredibly varied. Special forecasts, for example, are needed for such purposes as pigeon racing, defrosting of railway lines and load-shedding in cold weather. Climatological enquiries are too numerous to list, but might vary between information about the intensity of heavy rains and the movement of rain storms in connection with surface-water drainage problems, data in connection with the installation of ventilation equipment in the tropics and general climatological information for the Food and Agricultural Organisation in connection with the agricultural development of a colony. Probably the most spectacular example of meteorology as applied to everyday life has been the rain-making experiments which have been made, notably in Australia and the United States of America. It is perhaps pertinent to note, however, that these experiments have not, so far, produced any very practical results.

From the marine point of view, some recent interesting applications of meteorology come to mind. A recent book, *Winds, Waves and Maritime Structures**, emphasises the importance of detailed observations into the behaviour of waves in relation to the design of breakwaters. In a recent Bulletin of the American Meteorological Society there was an interesting account about the work of special teams of meteorologists employed by oil companies who have sunk shafts some distance off the coast in the Gulf of Mexico. This article emphasised the enormous expense which was incurred whenever these shafts had to be evacuated owing to hurricanes or other strong winds and justified the expense of meteorological consultants. The United States Weather Bureau published some time ago a very striking pamphlet on the number of lives and the amount of money and property that were estimated to have been saved as a result of the Hurricane Warning Service which that country has so successfully instituted.

**Winds, Waves and Maritime Structures.* By R. R. Minikin. C. Griffin & Co., 1950.

Nearer at home, prolonged meteorological research into the strength of vertical and horizontal wind gusts has been applied to the projected design of the bridge across the Severn. If such research had been made prior to the construction of the Tay Bridge, perhaps that tragedy would never have occurred. Another interesting application of meteorology to our national economy is found in the giant aero generators (windmills) which are being erected experimentally on the west coast of Scotland and Wales whereby the wind can be harnessed to augment Great Britain's electric supply.

The mass of meteorological observations in the Marine Branch, which have been sent in by hundreds of voluntary observers at sea during a period of about a hundred years, having been punched on to Hollerith cards, make it possible for relatively speedy replies to be given to the numerous enquiries which are received. These might include, say, enquiries about humidity data for carrying of special cargo from the United Kingdom to Australia, maximum and minimum temperatures recorded in mid-Atlantic on a stated month, or the average date of onset of the south-east trade in a certain locality. Enquiries of a more synoptic nature might include all the available ship observations in a stated area during a certain week in connection with some legal or insurance problem.

On another page in this number reference is made to Sir Robert Watson-Watt's comments about further applications of meteorology to the economic operation of ships.

There seems no doubt that meteorologists can do much, in conjunction with oceanographers and other research workers, to improve the economic and industrial efficiency of the world.

* * *

Regular readers of *The Marine Observer* will note a change in the quality of the paper and in the general presentation of the material. Instead of using art paper throughout, this will in future only be used for the reproduction of photographs; the rest of the pages will be on ordinary printing paper. The " Fleet List " at the end of *The Marine Observer*, instead of appearing quarterly, will now only appear half-yearly.

The reason for these changes is entirely one of national economy. Paper is expensive and in relatively short supply, and labour costs in the printing and paper trade are very high. Unless some economy is made the cost of the magazine would be excessive. There is no intention to lower the present high quality of the material appearing in this magazine, and it is hoped that readers will be forbearing and understand the practical reasons which have led to this economy.

MARINE SUPERINTENDENT.

India Meteorological Department

EXCELLENT AWARDS FOR SHIPS

The Director-General of Observatories, India, has informed us that nine ships voluntarily co-operating with the India Meteorological Department have been selected to receive " Excellent Awards " for meteorological work performed during the year 1950–51. Details of these nine ships are shown below.

This year's award is a copy of the publication *Climatological Charts of The Indian Monsoon Area*, published by the India Meteorological Department, and a whirling psychrometer, both suitably inscribed.

We wish to take this opportunity of congratulating the captains and officers concerned.

Ship	Captain	Observing Officers	Radio Officers
Barala ..	J. N. Richards ..	D. S. Hutton, M. R. North	
Dara	D. S. Johnston ..	—. Stott, —. Joss, Jan Sokalski	R. C. Whiting, A. E. Chalmers
Jalaganga ..	W. L. Atkinson ..	F. G. P. Mathews	S. K. Chatterji
Jalavijaya ..	J. Y. Kerr ..	—. Sarma, —. Sachinvala, —. Vancheswar, —. Kelkar	R. Vandergucht
Karanja ..	C. B. Mitchell ..	J. D. Stephinson, G. C. Johnson	J. D. Masterman
Khosrou ..	J. W. E. Cochrane	E. W. Richards, R. J. Ward, K. Chelliah	J. E. Martlieu
Nadir ..	B. E. Brewin ..	E. D. Robinson, J. E. Johnson, E. Pyle ..	M. Dore
Rajula ..	H. M. Macdonald	C. W. Jenkins, V. A. H. Iles	L. Barnet
Shahjehan ..	C. H. Norcliffe ..	D. P. Scott, —. Fernandez	J. C. Crowley

The Marine Observers' Log is a quarterly record of the most unusual and significant observations made by mariners.

The observations are derived from the logbooks of marine observers and from individual manuscripts. Photographs or sketches are particularly desirable.

Responsibility for each observation rests with the contributor.

April, May and June

SEA SURFACE TEMPERATURE

North Pacific Ocean

The following extract of a letter from the Commanding Officer, H.M.S. *Challenger*, has been forwarded to us by the Hydrographer of the Navy.

During *Challenger's* Cruises XII and XIII, in May and June, 1951, respectively, sea-surface temperatures were observed four times daily. The Centigrade scale was employed.

In order to take these temperatures as accurately as possible they were observed by Surveying Recorders, using a canvas bucket and H.O. Surface Thermometers.

These temperatures were plotted on a tracing made to fit Current Charts as shown in Air Ministry Publication M.O. 485.* This was done in order that the connection between sea-surface temperature and known ocean currents could be readily observed.

Temperature contours on Cruise XII in May follow very closely the current arrows shown on the current charts in the following ways:

(*a*) The 20° contour agrees very closely with the arrows showing the Kuro Siwo current.

(*b*) Cooler water extends north of this until the Oya Siwo current turns eastwards, south-east of Hokkaido, when a pronounced drop of 10°C was found in approximate position 40° 30′N, 149°E, the belt of cooler water running about 072° from here.

(*c*) There is then a steady drop in temperature northwards until approximate position 44° 30′N, 154° 30′E, when a sharper drop is noted where the Oya Siwo current turns south-eastwards.

On Cruise XIII on 8th June the observations show a gentle rise in temperature over 24 hours of 4°C in approximate position 27°N, 135°E. After this the temperature remained reasonably steady until a position 7° 30′N, 143°E, where a small sharp rise and fall (max. 29·9°C) was noted. This coincides with the position of a weak easterly counter-current shown in pecked line on the current chart. From this point until the Equator was reached a steady average of 29·25°C was recorded.

STRONG CURRENT

Vicinity of Grand Canary

M.V. *Tarkwa.* Captain G. D. Simpson. Liverpool to Dakar. Observer, Mr. R. Martin, 2nd Officer.

4th June, 1951. Whilst approaching the NE coast of Grand Canary, steering 199° at 14 knots, a strong set was experienced, direction 202° at 6 knots. When under the lee of the land this set was no longer experienced and course altered to 180°(T). This course was afterwards maintained without any further allowance for set. The speed over the ground was checked by visual bearings.

Note. This appears to have been an unusually strong set, since it is stated in *Africa Pilot*, Part I, Tenth Edition, 1939, page 32, that the rate of current among the Canary Islands is from 0–30 miles per day.

DISCOLOURED WATER

North Pacific Ocean

M.V. *Jessmore.* Captain C. G. Killick. Panama to Los Angeles. Observer, Mr. P. H. Warne, 3rd Officer.

23rd April, 1951, 2145 G.M.T. Dense patches of plankton were observed. The coloration varied from dirty brown to grey-brown, covering an area about 2–3 miles square. The water had a strong smell and its temperature was constant at 78°F. Soundings were taken but no bottom was recorded. Wind WSW force 2. Slight sea and swell. Air temp. 77°.

Position of ship: 20° 00′N, 106° 00′W.

*Quarterly Surface Current Charts of the Western North Pacific with Monthly Chartlets of the China Seas. M.O. 485. Her Majesty's Stationery Office, London, 1949.

WATERSPOUTS

Indian Ocean

M.V. *Waiwera.* Captain L. J. Hopkins. Aden to Colombo. Observer, Mr. C. H. Tucker, 3rd Officer.

5th April, 1951, 0240 S.M.T. A waterspout was observed 1½–2 miles on the starboard bow. It appeared to be forming from the clouds like a dark cone, apex downwards, finally settling into disturbed sea and spray. It was travelling in a W'ly direction opposite to the ship's course, and while it was passing the ship a sound similar to the rushing of wind could be heard. It appeared to be rotating in a clockwise direction. Observations were interrupted by a tropical rain squall, but the spout appeared to turn towards the Equator before disappearing over the horizon. It attained a height of 3,000 ft. while passing the ship, but later observations gave the impression that it had gained momentum and size. It was visible from the ship for 10–15 minutes. The spout formed from Cb but it was preceded by Ac and followed by mainly low Sc. An hour later the sky had cleared. Air temp. 85°F, wet bulb 81°, sea 84°.

Position of ship: 7° 28′N, 77° 31′E.

China Sea

M.V. *Ajax.* Captain H. S. Wood. Manila to Hong Kong.

13th May, 1951, 1335 S.M.T. The vessel was in heavy precipitation when the clouds forward, where it was brightening, were seen to be in violent motion. This part of the cloud hung as a ragged curtain about 150 ft. above the sea in an approximate N–S line below the main cloud base at 500 ft. and the southern end of the curtain was being rolled up by the wind in an anticlockwise direction. The sea below was much disturbed, the spray being carried up to at least 50 ft. The whole area of rotation was from a quarter to half a mile wide and the wind could be clearly heard at a distance of one mile. During the observation period of 10 minutes the barograph fell 0·5 in. Air temp. 79·5°F, wet bulb 79·3°, sea 87°. Wind 165°, 16 knots.

Position of ship: 19° 36′N, 116° 18′E.

ABNORMAL REFRACTION

Persian Gulf

M.V. *Dwarka.* Captain J. Curry. Ras Tanurak to Mena al Ahmadi. Observer, Mr. K. Malawski, 3rd Officer.

31st May, 1951, 1515 G.M.T. The coastline and mountains in the vicinity of Bushire appeared to be elevated some 3° above the horizon at a distance of 76 miles bearing between 300°–360°. Madaira Reef buoy was visible distant 40 miles at the same height of eye (45 ft.) but was not visible from the deck above, some 10 ft. higher. Air temp. 87°F, sea 85°. Wind NW force 1.

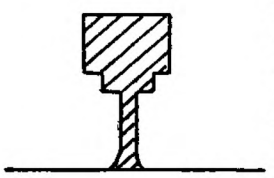
Position of ship: 28° 39′N, 49° 25′E.

Gulf of St. Lawrence

S.S. *Manchester Shipper.* Captain F. L. Osborne. Port Alfred to Manchester. Observer, Mr. J. Illingworth, 3rd Officer.

23rd June, 1951. During the day the sea had been very slight and visibility excellent, but there had also been a remarkable amount of refraction. At 1825 A.T.S. the radar showed a very distinct target bearing 272°(T) at a distance of 55,800 yards. The ship's position at this time was 50° 00′N, 62° 38′W, course 090°(T). The wind was E'ly force 3 and the sky was overcast.

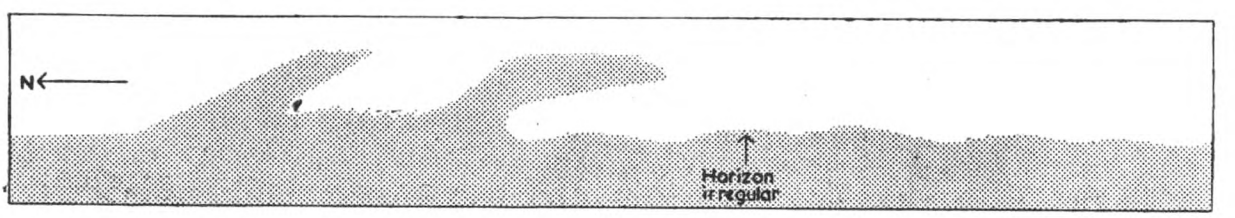
It was realised that this target could not possibly be land and was probably a vessel. Using binoculars the inverted image of a ship was seen above the horizon on the same bearing (see sketch). The target remained on the screen for 50 minutes and it became apparent that the ship was slowly overtaking us. Although the target on the radar display eventually faded for the period 50,000–20,000 yards, the inverted image of the ship remained in view for three hours, and even in darkness the navigation lights could be seen inverted. The ship overtook us at 0035 on the 24th, six hours after we first sighted her on radar. We were proceeding at about 14 knots, which gave her a speed of 18½ knots.



Note. This seems to be an excellent example of abnormal radar propagation (super-refraction) being experienced at the same time as abnormal visual refraction. The fading of the target between 50,000 and 20,000 yards is presumably due to the well-known effect of super-refraction, i.e. a lifting of the refracting layer from the sea surface which will give rise to a skip distance.

Off Port Elizabeth

S.S. *Selector.* Captain W. H. Slaughter. Observer, Mr. W. Tinkler, 3rd Officer. 12th May, 1951, 1230–1240 G.M.T. The horizon to the eastward appeared distorted, showing the form of a ragged, windswept cloud with anvil which

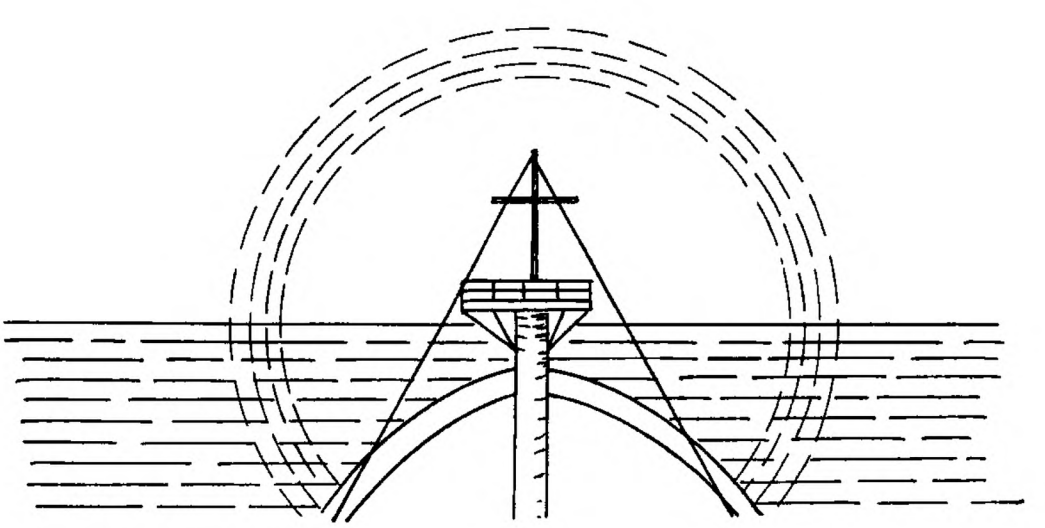


appeared to move rapidly to the northward continually changing shape until the horizon appeared normal again. The horizon to the southward appeared to be slightly irregular. The sky was cloudless. Air temp, 79°F, wet bulb 65°, sea 65°.

SOLAR RAINBOW

Indian Ocean

M.V. *Trelyon.* Captain F. J. Cornish. Aden to Sydney. Observer, Mr. J. M. Downard, 2nd Officer.



5th May, 1951, 0755–0855 G.M.T. A fierce rain squall occurred, throughout which a rainbow was observed. During the last 20 minutes the bow, which was a primary, became perfect in every detail, all colours being clearly defined. When first observed the bow was about 25° high. It then moved toward the ship and disappeared as the squall passed over the ship. During the last five minutes the bow appeared as a complete circle, only separated by the bow of the ship. Sun's declination 16° 03′N. Course 125°(T).

Position of ship: 24°S, 98°E.

LUNAR RAINBOW

Australian Waters

M.V. *Trelyon*. Captain F. J. Cornish. Aden to Sydney. Observer, Mr. P. Haggarty, 3rd Officer.

14th May, 1951, 1230 G.M.T. Towards the end of a fierce rain squall a perfect lunar rainbow was observed, showing green on the inside and yellow on the outside. The bow was 40° high and disappeared completely by 1234.

Position of ship: 39° 00′S, 144° 30′E.

IRIDESCENT CLOUD

Mediterranean Sea

S.S. *Esperance Bay*. Captain T. V. Roberts, R.D., R.N.R. Malta to Southampton. Observer, Mr. J. K. Wyles, 3rd Officer.

3rd May, 1951, 1820 G.M.T. A patch of Ci, about 10° west of the sun, in process of changing into Cc, became iridescent, showing pale green in the centre surrounded by pale pink which deepened at the outer edge. A larger patch of Cc at 5° from the sun became similarly iridescent at the side nearest to the sun. Numerous patches of Ci in the vicinity were also changing to Cc but showed no coloration.

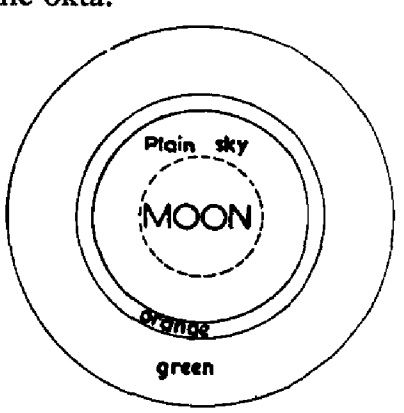
Position of ship: 36° 24′N, 2° 53′W.

LUNAR CORONA

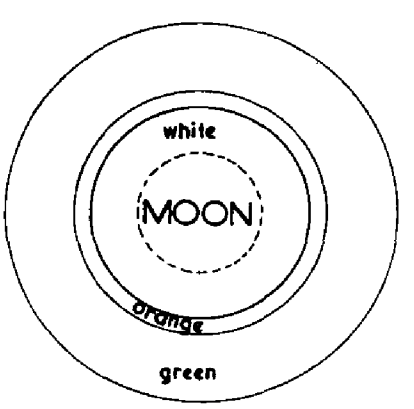
Red Sea

T.E.S. *Theliconus*. Captain T. W. A. Webster. Haifa to Mena al Ahmadi. Observer, Mr. P. J. E. Marshall, 3rd Officer.

18th June, 1951, 1750 G.M.T. A corona was observed around the moon. The inner band was a pale orange in colour whilst the outer, a much larger one, was a delicate shade of green. The moon was bearing 140°(T) with an observed altitude of 28° 24′. The cloud consisted of filaments of Ci at a great height amounting to less than one okta.



1750 G.M.T.



1805 G.M.T.

At 1805 the space between the moon and the orange band appeared white. By 1830 the corona had disappeared.

Position of ship: 18° 46′N, 39° 39′E.

RARE LUNAR HALO

South Pacific Ocean

M.V. *Condesa*. Captain H. Heal. Wellington to Panama. Observer, Mr. S. J. Edgington, 2nd Officer.

20th April, 1951, 0430 G.M.T. A complete lunar halo of radius 16° 44′ was observed, the moon being almost at the observer's zenith. Cs haze was present, probably covering the whole sky, with a patch of Ac to the NE and isolated Cb around the horizon. The halo was, periodically, wholly or partly obscured by layers of Ac moving at about 140° and by large Cb moving at about 360°. The halo disappeared at 1130.

Position of ship at 0600: 27° 32′S, 123° 43′W.

Note. This is a valuable observation of a rare form of lunar halo, which has only previously been recorded a very few times. The careful measurement of the radius of the halo, 16° 44′, makes its identification certain. The theoretical radius of this halo, known as Rankin's halo, from its first observer, is 17° 06′, but it has been observed with radii a little less or a little more than 17°. The importance of measuring the radius of a halo as exactly as possible, particularly in the case of one which appears larger or smaller than those more commonly observed, is well shown by this observation, since another rare halo is known which is only a little larger, having a radius of about 19°. The halos of 17° and 19° are very rare because their formation is due to the refraction of light through ice crystals of pyramidal form, and these crystals seldom occur. Four other rare halos, of radii 8°, 23° 20′, 24° 37′ and 32° respectively, also require the presence of pyramidal crystals. It will be noted that two of these, the halos of 23° 20′ and 24° 37′, are very little larger than the most common of all halos, the halo of 22° (more exactly 21° 50′).

We are fortunate in also having recently received an observation of the halo of 32° from M.V. *Dominion Monarch*. This, being a July observation, will appear in the next number of *The Marine Observer*.

COLOUR PHOTOGRAPH OF THE GREEN FLASH

Antarctic Ocean

Marine observers of the green flash at sunset or sunrise will be interested to hear that Mr. Masao Hanzawa, of the Central Meteorological Observatory, Tokyo, has succeeded in photographing this phenomenon in colour, from a whaling vessel in the Antarctic Ocean in lat. 63° 39′S, long. 15° 59′E. Mr. Hanzawa was one of four meteorologists accompanying the Japanese whaling fleet during the 1950–51 season.

A reproduction of the photograph, which was taken at sunset on 4th January, 1951, has been received in the Meteorological Office library and clearly shows the green segment of the sun on a sharp sea horizon with no apparent distortion. A long roll of stratocumulus is seen a few degrees above the horizon. Air temperature was 30·9°F, the sea being warmer, 33·8°F.

As Mr. Hanzawa remarks, this is probably the first colour photograph taken of the green flash.

Unfortunately we are unable to reproduce colour photographs in this magazine.

MAGNETIC AND RADIO DISTURBANCE

North Atlantic Ocean

The following is an extract from a letter received from Captain C. B. Osborne, R.M.S. *Samaria*:

On Sunday, 17th June, between 1700 and 2050 G.M.T., between 56° 10′N, 34° 25′W, and 55° 55′N, 36° 09′W, steering by gyro 256°, it was noticed that the standard and steering magnetic compasses were wandering considerably. A very

careful check was kept and the following were the readings when comparing the standard with the gyro compass repeater, which was found to be correct:

1750: N 74°W	1900: N 74°W	2010: N 73°W
1800: N 70°W	1910: N 74°W	2020: N 74°W
1810: N 74°W	1920: N 73°W	2030: N 73°W
1820: N 76°W	1930: N 73°W	2040: N 74°W
1830: N 74°W	1940: N 74°W	2050: N 74°W
1840: N 74°W	1950: N 74°W	2100: N 74°W
1850: N 72½°W	2000: N 73°W	

The gyro heading was 256(T) all the time. A large sunspot had previously been observed, by sextant, during the morning and the erratic behaviour of the compass was put down to this, although on the compass settling down at 2040 the sunspot was still there.

The following day the same phenomenon occurred, though with what appeared to be diminishing power, as the compass was not deflected to quite the same extent, as will be seen below. Course was then 252° by gyro, position at 1830 being 54° 28′N, 45° 30′W.

1830: N 78°W	1900: N 76°W	1930: N 75°W
1840: N 77°W	1910: N 76°W	1940: N 75°W
1850: N 76½°W	1920: N 75°W	1950: N 75°W

A check was made with the radio office to find out if any interference was being experienced, and in both cases the radio officer reported that no signals could be received by the ship's apparatus. On the magnetic compass settling down, the radio office reported signals were being received.

It would appear from the above, that the interference was almost certainly caused by the sunspot, in spite of the fact that it was still there after the compass had settled down. It would be interesting to know whether the above effects were felt elsewhere, such as by British radio stations, etc., or whether the area affected was small. It is regretted that the radar was not tried out during the above times, but the weather was quite clear and fine and I am afraid this was overlooked. It would have been interesting to have noted whether the radar (268) became affected at the time the compasses and radio apparatus were upset.

Copies of the letter were sent to various authorities and the following comments received:

From the Navigation and Direction Division, Admiralty

No reports of magnetic disturbances have been received from ships, but it has been verified that a fairly small magnetic and ionospheric storm did occur on 17th–18th June causing considerable magnetic disturbance in the position of the ship, which was very close to the belt of maximum auroral frequency.

From the Admiralty Compass Observatory

It has been verified from the Radio Research Station at Slough that there was considerable magnetic disturbance on 17th–18th June, changes of ¼° of variation being noticed at Slough on the morning of 18th, ½° at Eskdalemuir and more than 1° at Fraserburgh (57°N).

It is evident that a fairly intense magnetic and ionospheric storm occurred then, and since the ship was in the middle of the auroral zone the disturbance would be very marked.

The coincidence of disturbed radio conditions is usual and no doubt the whole occurrence was associated with the large sunspot. It is usual for such disturbances to take place about two days after the central meridian transit of the sunspot and to last for several hours, but since the spot is still visible for another four days or so before it disappears round the western limb of the sun, the master of the ship would still be able to see it after the storm had ceased.

No reports of similar interference with compasses on the dates in question have as yet been received from other sources.

From the Overseas Telecommunications Department, G.P.O.

A large number of sunspots were visible during June, and a large group occurred with its central meridian passage on the 18th. This was probably the sunspot referred to in the report received from the R.M.S. *Samaria*. Disturbed magnetic conditions were recorded at the Abinger Magnetic Observatory during the periods 1800 G.M.T. on 17th June to 0900 on the 18th, and 0300 on the 19th.

There were widespread disturbances on Post Office radio circuits between 0000 and 1800 on 18th June, and on the Montreal circuit signals continued to be weak until 1900.

The period on the 17th, when the *Samaria* magnetic compasses were wandering, coincides with the onset of magnetic disturbances recorded at Abinger, but during the corresponding period on the 18th magnetic conditions at Abinger were quiet. Conditions on the Post Office radio circuits on the 17th were normal. On the 18th the Montreal circuit gave weak signals during the period when no signals were received by the *Samaria*.

It may be that the effects observed by the *Samaria* were due to a magnetic storm producing widespread magnetic disturbances but only local radio disturbances on the 17th, which were followed by local magnetic disturbances but more widespread radio disturbances on the 18th.

Recently a report of an investigation into what are called " Polar blackouts " was published, and there is a marked similarity between the conditions reported from the *Samaria* and those described in this report. Little seems to be known, however, about the nature of these blackouts or their cause.

From the Central Forecasting Office, Dunstable

The conditions as regards short-wave reception were normal during most of 17th June but deteriorated during the evening, and from about 2000 G.M.T. all through the night were very bad indeed. No messages were coming through from places such as Greenland, Iceland, New York, etc. During daylight hours of 18th June conditions were better but were still abnormal.

All the evidence therefore points to a considerable degree of general disturbance at the time.

ABNORMAL MAGNETIC VARIATION

South Atlantic Ocean

S.S. *Geologist*. Captain A. E. Jackson. Las Palmas to Cape Town. Observers, the Master, Mr. D. V. Jones, Chief Officer, Mr. A. K. Jones, 2nd Officer, and Mr. J. O. Coleman, 3rd Officer.

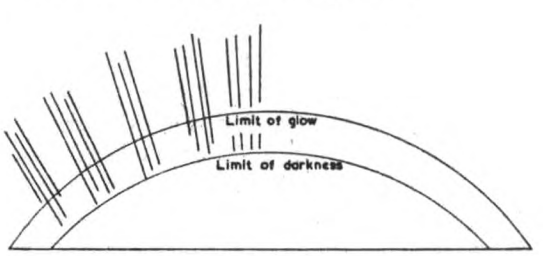
20th June, 1951. From noon (apparent time) in 21° 48′S, 07° 48′E, to about 0100 on the 21st in D.R. position 24° 00′S, 09° 36′E, abnormal magnetic variation was experienced. On a course of 142°(T), which had previously given deviations of 4°E to 4½°E, the deviation at 1505 A.T.S. was found to be 6¾°E. The deviation rose to a maximum of 7½°E and then decreased to normal. Numerous bearings of bodies having both easterly and westerly hour angles were observed and the position and chronometer error verified.

Note. This item was referred to the Hydrographer of the Navy and resulted in the issue of *Admiralty Notice to Mariners, No. 2237 of* 1951, entitled " Walvis Bay—reported magnetic anomaly westward ".

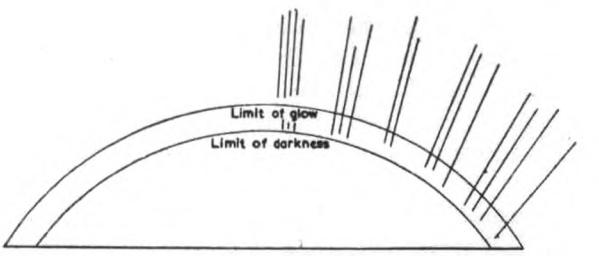
AURORA

North Atlantic Ocean

M.V. *Kaikoura*. Captain I. M. Fenwick. Philadelphia to Montreal. Observer, Mr. G. S. Gunn, 3rd Officer.



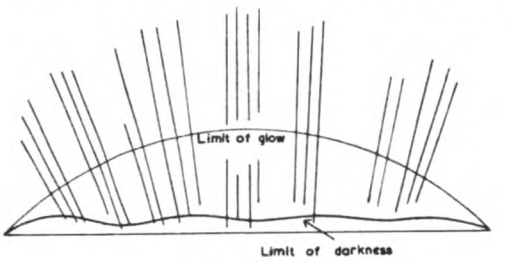
0245 G.M.T.



0300 G.M.T.

27th May, 1951, 0100 G.M.T. Aurora was observed bearing 300°–56°(T). To an altitude of 22° there was a semicircle of darkness, above which the northern lights reached an altitude of 34°. At 0245 shafts of light began playing to an altitude of 50° between 300° and 350°, while the area between 350° and 56° remained unchanged. At 0300 the N–NE portion began playing shafts of light while the N–NW

portion took on the appearance of cirrus clouds. At 0311 the whole aurora began playing with the shafts of light penetrating into the dark semicircle which was gradually decreasing its altitude and at 0320 took on the appearance of a hill at an



0311 G.M.T.

altitude of 3°. The display began to fade at 0345 and had dispersed by 0420. The stars Capella, Castor and Pollux were clearly visible throughout the display in the dark semicircle and the constellation Cassiopeia was visible through the lights. There was no cloud.

Position of ship: 41° 48′N, 68° 17′W.

Note. The special point of interest in this observation is the fact that the auroral rays penetrated below the auroral arc into the dark segment, which is unusual. The rays normally start from the arc itself, as shown in the first two sketches. This is also the only observation of aurora received for the month of May, 1951, from the sea, and none were recorded at stations in the British Isles, in spite of considerable sunspot activity during the greater part of the month.

METEORS

North Atlantic Ocean

M.V. *Jessmore.* Captain C. G. Killick. Manchester to Panama. Observer, Mr. P. H. Warne, 3rd Officer.

7th April, 1951, 0105 G.M.T. A white meteor appeared from behind cloud in position R.A. 6h. 45m. dec. 12°N, near Betelgeuse. Its magnitude was −2 and it left a white trail, the end of which was disappearing as the meteor reached its lowest point. The whole phenomenon lasted about five seconds.

Position of ship: 36° 01′N, 36° 36′W.

14th and 15th April, 1951. Three meteors were seen on consecutive nights in the same part of the sky (the constellations Canis Major and Minor and Gemini) and were similar to each other in appearance. They were reddish in colour, of magnitude −1, and their trails were only momentary. The first was seen at 0116 on the 14th (position 17° 23′N, 68° 39′W), travelling west and covering an arc of 8°–9° in about one second. It passed just south of Sirius and disappeared midway between Sirius and Almirzam. The second was seen at 0230 on the 14th (position 17° 14′N, 68° 51′W), travelling in the same direction and at the same speed over an arc of 6°, appearing near Procyon.

The third was seen at 0300 on the 15th (position 14° 10′N, 73° 25′W), travelling from R.A. 7h. 0m. dec. 17½°N, to R.A. 6h. 26m. dec. 28°N, a distance of 13°, in two seconds. The trail of this meteor was fainter than that of the others.

M.V. *Trelevan.* Captain S. Hawker. Cristobal to Hull.

16th June, 1951, 0635 G.M.T. A meteor was observed bearing 090°(T) at an altitude of about 30°. It crossed the Square of Pegasus and the duration was some two or three seconds. It was at least twice the size of Jupiter, probably more; the planet was close by and comparison was easy. The trail extending about 10 to 15 times the diameter of the meteor, was reddish-orange with a white edge. The brilliance of the trail was such that it lit up the fore end of the ship like a flash of lightning.

Position of ship: 32° 20′N, 58° 10′W.

South Atlantic Ocean

M.V. *Levernbank*. Captain T. S. Robertson. Bahia Blanca to Durban. Observer, Mr. D. Moore, 3rd Officer.

2nd May, 1951, 2108 G.M.T. A very bright reddish-white meteor, of magnitude −2·5, was observed bearing 107°(T), altitude 22° 30′, just south of λ Scorpii. It travelled SW for about four seconds and was followed by a second meteor of equal brilliance. They both disappeared bearing 147°(T), altitude 6°, the total time of flight being seven seconds. No trail was seen.

Position of ship at 1800: 33° 04′S, 3° 50′E.

North Pacific Ocean

M.V. *British Marquis*. Captain W. C. Wall. San Pedro to United Kingdom. Observer, Mr. R. E. Chalklin, 3rd Officer.

29th May, 1951, 0525 G.M.T. A meteor was sighted on a bearing of 090° at about 40° altitude, heading due north. It appeared from behind cloud and was plainly visible for about five seconds before disappearing into cloud. Both the meteor and its trail were a silvery colour; streaks and sparks were ejected from the train, which turned from silver to a reddish colour.

Position of ship: 17° 42′N, 102° 32′W.

South Pacific Ocean

S.S. *Tongariro*. Captain C. P. Robinson. Brisbane to Balboa. Observer, Mr. J. Bone, 3rd Officer.

9th April, 1951, 0547 G.M.T. A bright meteor of magnitude comparable to Sirius, appeared above Benetnasch, in approx. R.A. 13h 20m, dec. 50°N, and dropped toward the horizon between Benetnasch and Mizar. It appeared to explode and disappeared in position approx. R.A. 13h 40m, dec. 50° 24′N, at an altitude of about 4°. The duration of flight was about one second.

Position of ship: 23° 11′S, 126° 21′W.

9th April, 1951, 0649 G.M.T. A brilliant blue-white meteor, of magnitude comparable to Venus, appeared below Arcturus, approx. R.A. 14h 8m, dec. 20° 18′N, and travelled parallel to the NE horizon, disappearing in position approx. R.A. 13h 24m, dec. 35° 00′N. The duration of flight was two seconds.

Position of ship: 23° 07′S, 126° 10′W.

19th April, 1951, 0301 G.M.T. A large brilliant blue meteor with a trail of red sparks was observed on a bearing of 320° at about 25° altitude, dropping toward the NW horizon. After being visible for about one second it exploded and disappeared, re-appearing almost immediately on its original course and finally disappearing behind Cu at about 15° altitude. The duration of flight was about two seconds. No trail remained.

Position of ship: 00° 24′S, 85° 39′W.

Australian Waters

M.V. *Cheshire*. Captain P. H. Potter. Fremantle to Melbourne. Observer, Mr. H. Traynor, Junior 3rd Officer.

2nd April, 1951, 2225 S.M.T. A bright white flash occurred in the sky, presumably caused by a meteor. The flash occurred about 10° west of Canopus and a trail of light moved rapidly toward the star and extended for about 5°. When the trail was 4½° from Canopus it was seen to make several distinct spirals. The light was a bright white colour and was considerably brighter than Canopus. The

trail remained stationary for about 10 minutes and then began to fade. One-and-a-half hours later a distinct white haze could still be seen in the sky where the phenomenon occurred. The sky was clear.

Position of ship: 33° 30′S, 114° 38′E.

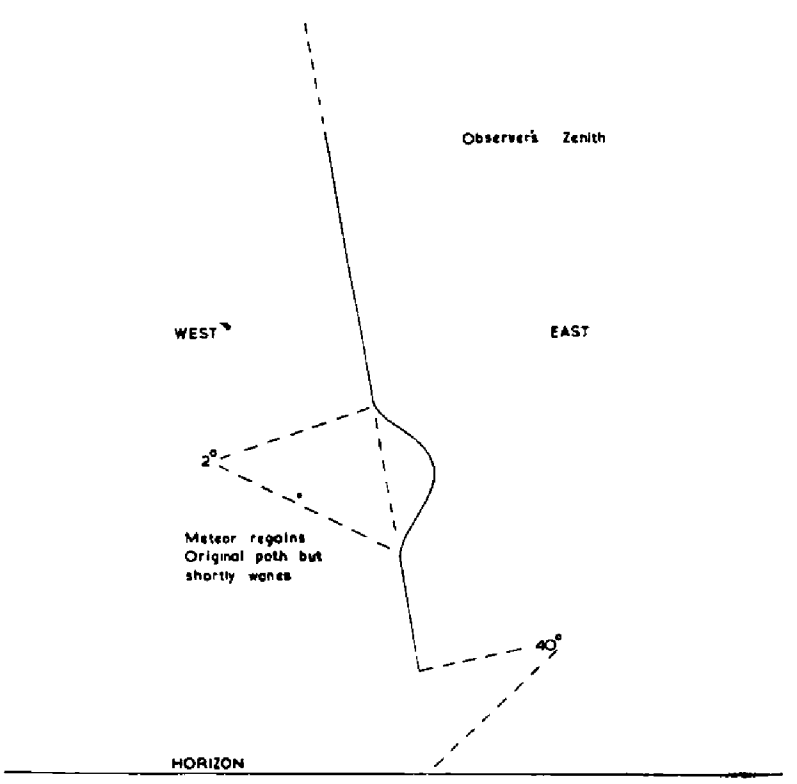
Note. This is an interesting observation, in two respects. A spiral track is only very occasionally observed and it is a very rare occurrence for the trail to persist for such a great length of time. Still longer periods of persistence, up to over two hours, are, however, on record.

In the case of a persisting trail, the matter of which it is composed is under the influence of the winds of the high upper air. The average height of appearance of a meteor is 80 miles and that at the time of disappearance is 50 miles. It is interesting therefore to plot the position of a persisting trail in relation to two or more named stars, at suitable intervals of time. If this were done, for the same meteor, by two or more ships in different positions, it would enable the speed and direction of the wind at this great height to be computed. This would be of great value to the meteorologist, since our knowledge of such winds is at present very small. For this purpose it is not necessary for the trail to last for an hour or more; any trail which lasts long enough to show a definite movement in the sky would suffice.

Gulf of Aden

S.S. *Alavi.* Captain H. Murray. Colombo to Jeddah. Observer, Mr. W. D. Merchant, Chief Officer.

27th May, 1951, 0055 G.M.T. A meteor was observed flying in and parallel to the Milky Way from S 10°W to N 10°E. It came into sight when 60° above the southern horizon and reached its maximum brilliancy immediately prior to and after the flash. The track showed clearly that it was deflected off its course but



curved back to regain it. The flash lit up the whole of a clear sky and the track remained visible for about seven seconds. This, together with the flash, was a brilliant white and was the brightest ever seen by this observer. The flash occurred in the vicinity of Alderamin, bearing N 10°E, altitude 40°.

Position of ship: 12° 24′N, 47° 46′E.

Nautical Occasion at Harrow

PRESENTATIONS OF BAROGRAPHS TO CAPTAINS

On 27th November, 1951, Sir Nelson Johnson, Director of the Meteorological Office, was "At Home" to the Merchant Navy at the Meteorological Office in Harrow. The occasion was the presentation of barographs to the captains of four merchant ships in recognition of their long service as voluntary observers at sea on behalf of the Meteorological Office.

Bearing in mind that the Meteorological Office began its life under the command of a seaman, Admiral Fitzroy, and was in fact primarily established for the benefit of merchant shipping, it was appropriate that this function should have been held at the home of the Marine Branch. The occasion brought to mind the long association that the Meteorological Office has had with merchant shipping throughout its existence.

As announced in the October, 1951, number of this magazine, Captain Fitzgerald of the Cunard Company's *Vardulia*, Captain Pilcher of the New Zealand Shipping Company's *Haparangi*, and Captain Whittle of the Royal Mail Lines' *Asturias*, were the recipients of this award on this occasion. Captains Wood, Anderson and Spriddell, the Marine Superintendents of the companies concerned, were also present. Captain Eckford of the Pacific Steam Navigation Company's *Cuzco* was at sea at the time and arrangements were made for the presentation to be made to him at Liverpool on his ship's return there.

The occasion was marked by a little luncheon party at which the guests included, in addition to those mentioned above, representatives of The Honourable Company of Master Mariners in the persons of Captain Macky, Senior Warden, Captain Fisher, a member, and Mr. Smith, the Clerk. The Honourable Company has been closely associated with such presentations on previous occasions and has always taken considerable interest in meteorology as applied to the Merchant Navy. Captain Quick, Principal Examiner of Masters and Mates, who is a member of the Meteorological Committee, was also present, together with several senior members of the Meteorological Office staff.

Sir Nelson Johnson, in making the presentations immediately after the luncheon, emphasised the importance of maritime observations to the meteorological services of the world, both for synoptic and climatological purposes. He mentioned that the Ocean Weather Ships received a good deal of publicity, but the masters and officers of merchant ships who have for so many years done such consistently useful meteorological work at sea in all oceans do not get the same limelight. He was very glad to have the opportunity of publicly thanking all voluntary observers in Selected Ships and indeed the entire shipping industry for the fine spirit of cooperation which enabled this useful meteorological work to be carried out.

Sir Nelson spoke of the long connections with the Meteorological Office of each of the three shipping companies represented, connections dating back to the founding of the Meteorological Office under Admiral Fitzroy nearly 100 years ago.

Before presenting the barographs he gave some details about the quality of the work done by Captains Fitzgerald, Pilcher and Whittle during, in each case, more than 15 years of observing and recording the weather at sea.

Captains Fitzgerald, Pilcher and Whittle, in accepting their awards, expressed their satisfaction that their work had proved so useful, and stressed in general terms the value to the seaman of up-to-date and accurate meteorological information all over the world. Captain Macky, on behalf of the Honourable Company, said how glad he was that there was such a pleasant relationship between the shipping industry and the Meteorological Office generally.

MARINE SUPERINTENDENT.

Fox Photos Ltd.

Luncheon party at the Meteorological Office, at Harrow on the occasion of the presentation of barographs, November, 1951

Fox Photos Ltd.

The presentation of the barographs. *Left to right*—Capt. W. J. Fitzgerald, Capt. H. G. Whittle, Sir Nelson Johnson, Capt. C. R. Pilcher.

To face page 73

Photo by R.A.F.

Orographic cloud over Boreray (57° 52′ N. 8° 29′ W), viewed from a north-westerly direction, 5th May, 1942.

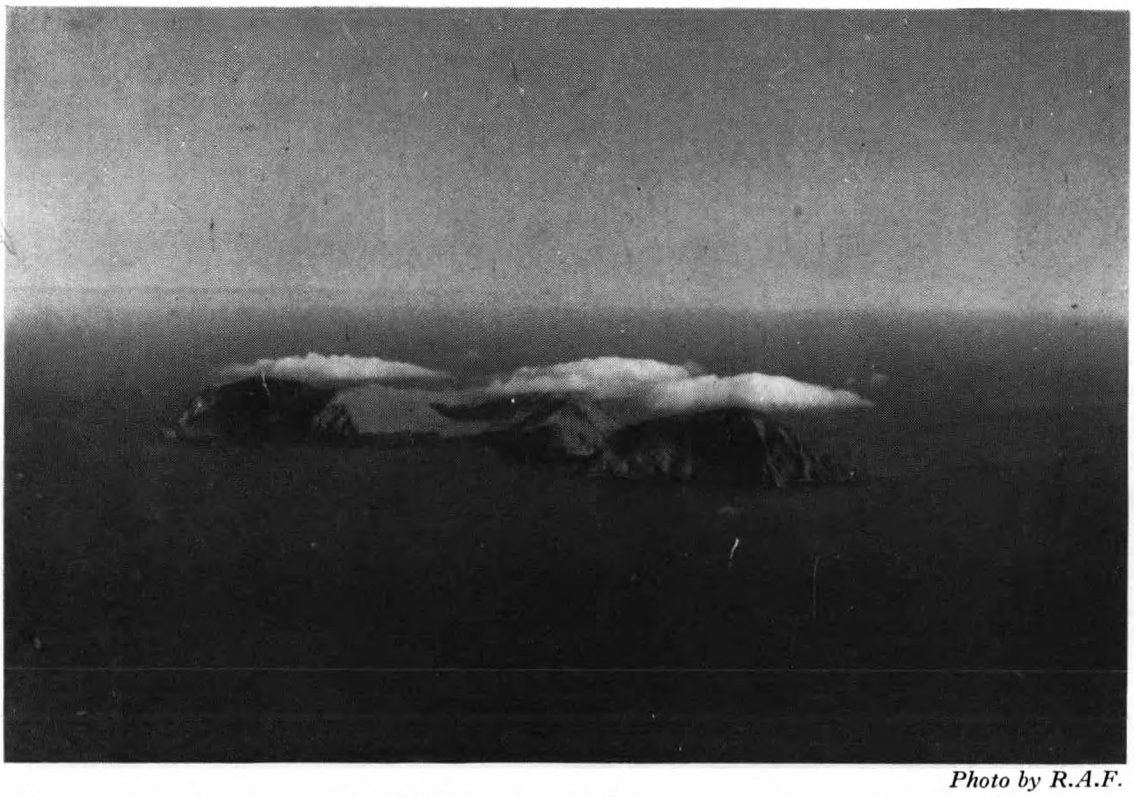


Photo by R.A.F.

Orographic cloud over St. Kilda, viewed from a north-westerly direction, 5th May, 1942

Evaporation, Humidity and Condensation

By P. R. BROWN, M.Sc., A.R.C.S., D.I.C.
(Marine Branch, Meteorological Office)

Liquids and gases both consist of minute particles known as molecules, which are much too small to be visible to the human eye. In gases the molecules are much less close together than in a liquid and they move throughout the gas with far fewer collisions with other molecules. The molecules in a liquid are very much closer together, and each spends most of its time in collisions and also is constantly under the attraction of those molecules around it. In the interior of a liquid, this attraction works in all directions and so may have no resultant effect on the molecule. Now consider a layer one molecule thick on the surface of a liquid. Any molecule in this layer is not equally surrounded by others and hence there is a resultant attractive force inwards towards the liquid and perpendicular to the surface of the liquid. Therefore there will be a force inwards on this layer or film and consequently the surface layer will act like a tight membrane holding the liquid inwards.

When a molecule in the liquid moves towards the surface and enters the surface layer, its velocity is reduced by the attractive force that is directed inwards at liquid's surface. Its motion may therefore be completely stopped or reversed; or its velocity may be so large that it can overcome this attractive force and enter the air or other gases surrounding it, although only with its velocity reduced by the operation of this attractive force. These molecules which escape form the vapour of this liquid, and this process of the ejection of molecules is termed *evaporation.* When water in contact with air evaporates, the water vapour will mix with the air, forming moist air.

The velocity of molecules in a liquid, or a gas, increases with increasing temperature. Hence, as evaporation depends on the facility with which molecules leave the surface of the liquid, it will increase with increasing temperature.

Evaporation of Water in an Enclosed Space

Consider when some water is placed in an enclosed space otherwise empty, and the whole is kept at a uniform temperature. Evaporation occurs, there being a flow of molecules escaping from the water to the space. These molecules travel about in the space having collisions with other molecules of water vapour and with the walls of the enclosed space. Some molecules eventually strike the water surface and are drawn inwards by the attraction of other molecules in the liquid. The more molecules of water vapour that there are in the space, the more will return to the liquid. Thus a stage will be reached when as many molecules are returning to the liquid water as are leaving it and then the effective evaporation will have ceased. The enclosed space above the liquid is now said to be *saturated* with vapour. But while there is no net transfer of water from the liquid to the vapour state there is a continual exchange of molecules at the liquid water surface, the same number returning to the liquid as are being ejected from it. Before this saturated stage is reached the water vapour is said to be *non-saturated.*

Evaporation of Water into the Atmosphere

When a water molecule leaves a liquid water surface and enters the free atmosphere it may never return to that surface, and thus there will be a continual flow of molecules from the liquid water and evaporation will continue. Thus it is possible under favourable conditions for all the water to evaporate, the rate of evaporation depending on the temperature. This is the reason for the complete drying up of puddles in the street.

Vapour Pressure

Where water vapour exists, it exerts a pressure, due to the impact of the vapour molecules on any surface in contact with it. This *vapour pressure* depends on the temperature and on the degree of saturation. When the vapour is saturated this pressure is known as the saturation vapour pressure. The vapour pressure exerted by water vapour in the atmosphere is not affected by the presence of the air with which it is mixed.

The vapour pressure exerted by liquids, being due to the impact of the escaping molecules, varies with the curvature of the liquid surface, being higher for a convex surface than for a flat one and lower for a concave surface.

Heat is used up in the process of evaporation. Hence if no heat is given to water which is evaporating, it will cool.

Humidity

The atmosphere consists of a mixture of oxygen, nitrogen, small quantities of other substances and water vapour. While the percentages of oxygen and nitrogen remain more or less constant, the percentage of water vapour is very variable. Now, we know that at a given temperature a given space will hold a certain definite amount of water vapour when it is saturated, and this amount is not affected by the presence of air. Tables are available giving the saturated vapour pressure corresponding to any temperature. The *relative humidity* is the ratio of the actual vapour pressure to the saturated vapour pressure at the same temperature. Since the vapour pressure is proportional to the weight of the vapour in a given space, the relative humidity is also the percentage ratio of the weight of water vapour that a space holds to that it could hold if it were saturated at the same temperature. If the water vapour content of a space remains constant, heating will lessen the relative humidity, whereas cooling will increase it.

The *absolute humidity* or *moisture content* is the density of the water vapour present, i.e. the weight of water vapour per unit volume.

It is the relative humidity rather than the absolute humidity that gives an indication of what we commonly call dampness or dryness.

If an atmosphere containing some aqueous vapour is gradually cooled, a temperature will be reached at which the vapour will begin to condense. This temperature is called the *dew point*. It is clearly the temperature at which the quantity of water vapour present would saturate the air, and it depends, therefore, only on the absolute humidity.

The Measurement of Humidity

Measurements of humidity are often made by a wet and dry bulb hygrometer, which operates on the principle of the cooling caused by evaporation. This hygrometer consists of two thermometers, the bulb of one being covered with muslin or wick, which is kept moistened. The " dry bulb " records the air temperature; evaporation takes place from the muslin or wick, thus cooling the " wet bulb " to an extent depending on the humidity of the air. If the air is saturated with water vapour no evaporation will take place and the two thermometers will indicate the same temperature. The temperature the " wet bulb " reads is known as the *wet bulb temperature* and is the lowest temperature to which the air can be cooled by adding water vapour to it.

The rate of evaporation from a wet bulb thermometer and hence the amount to which its temperature is below that of the dry bulb (or the *depression* of the wet bulb as it is known) depends on the rate at which air is passing over it. If the wet bulb is in a thermometer screen the ventilation depends on the strength and direction of the wind outside, and as these are varying there is some uncertainty in the determination of the humidity from such observations. For a given humidity,

as the speed of the wind flowing past the wet bulb increases, the depression of the wet bulb also increases, till it reaches a maximum value when the wind speed is about 4 knots. Any increase of the wind above this value leaves the amount of the depression practically unchanged. If, therefore, we use a psychrometer in which the wet bulb is " aspirated " so that the wind-flow past the bulb never falls below 4 knots, a much more precise measurement of humidity can be made.

Condensation

When a space containing water vapour is cooled, a stage will be reached when the space is saturated. If this space is cooled further, some of the water vapour will condense to form liquid water (unless supersaturation occurs), with the vapour pressure always being equal to the saturation vapour pressure at the existing temperature. If a liquid water surface exists in this space, there will be a net transfer of water molecules from the vapour to the liquid when the vapour is cooled past the saturation point.

Condensation within the body of the vapour is facilitated by the presence of minute particles of hygroscopic substances, known as *condensation nuclei.* These usually exist in large numbers in the lower layers of the atmosphere. They consist chiefly of certain compounds of sulphur and other products of combustion present in smoke from factories and domestic fires, and of salt from sea spray. These particles have the power of attracting the water vapour molecules, and act as nuclei on which condensation of the vapour may take place. Condensation may take place on these hygroscopic particles with the relative humidity as low as 75 per cent.

It is possible, if no condensation nuclei are present, for a space to contain a larger amount of water vapour than is necessary for saturation, and the space is then said to be *supersaturated.* Even in the absence of any condensation nuclei, however, droplets of condensed water will be formed by chance collisions of molecules if the vapour is sufficiently supersaturated.

The causes of cooling of air leading to condensation of water which most affect the care of ships' cargoes are:

(*a*) contact with solid bodies which are at a lower temperature;

(*b*) mixing with air at a lower temperature.

An example of (*a*) above is at the window of a room containing warm, moist, but unsaturated air when the temperature outside is low. Here the air outside cools the window; this in turn cools the layer of air in contact with it on the inside to a temperature below its dew point, causing condensation on the inside of the window.

It is important to remember in regard to the care of ships' cargoes the increased condensation that is liable when the cargo is hygroscopic and when the surface of the cargo material has fine pores. In the latter event, if the water does condense, the water surface will consist of many concave surfaces and, as we have seen, the vapour pressure over this will be lower, and hence further condensation will occur at a lower vapour pressure than over a flat surface.

Editor's note.—An example of water vapour condensing and forming clouds when moist air is cooled can be seen in the photographs facing page 73. In this case, the air is cooled by being forced to rise over the high ground of the islands.

Meteorology in relation to the Carriage of Goods by Sea

By C. E. N. FRANKCOM

(The text of a lecture given to the Honourable Company of Master Mariners aboard their headquarters' ship *Wellington* on 12th December, 1951)

It is unquestionably one of the primary duties of a master to deliver his ship's cargo in good condition at the end of a voyage. The master of a merchant ship must constantly bear in mind the interests of a large number of people—the producer or grower of the goods, the shipper, the ship owners, the underwriters,

the consignee and finally the consumer—all of whom may have a great financial interest in the cargo.

There was no time in our history when it was more important to avoid waste and inefficiency. Bad out-turns of cargo imply both. Our country is hard up. There is a world shortage of raw materials, manufactured goods and, in particular, food. In the near future there will undoubtedly be formidable competition in the shipping world from Germany and Japan. Many countries that did not own ships before the war are now ship-owners in quite a big way.

It is essential therefore in the national interest to do everything possible to ensure that cargoes carried in British ships are delivered at their destination in good condition, and to preserve Britain's international reputation in this matter. It is with these thoughts in mind that the subject for this paper was chosen.

The writer's interest in this question has been stimulated by various papers written over a number of years by Mr. Duly and his associates, both in the U.S.A. and in this country, and more recently by Colonel Bates—largely on the subject of the artificial ventilation of cargoes.* This aspect will be commented upon later in this paper.

Some effects of weather on grain

There is probably no other single factor which has a greater influence on the condition of cargoes, both pre-shipment and during carriage in the ship, than the weather. Consider a simple case such as grain. The meteorological history associated with the grain prior to its arrival at the elevator, including such factors as good or bad growing seasons, good or bad harvests, distance travelled by rail, etc., will affect its moisture content and its weight per bushel and hence its behaviour aboard ship.

Meteorological conditions during its sojourn in the elevator and during loading in the ship may further modify its moisture content. Consider, for example, the conditions at grain ports as widely scattered as Churchill, Vancouver, the River Plate and Geelong in Australia; not only do the meteorological conditions at each of these ports during the grain-loading season vary enormously, but the physical conditions of loading are so varied that the weather can have a much greater effect in one port than another.

Assuming that the vessel has a full cargo of grain the problem of its safe carriage is not particularly complicated, provided normal seamanlike precautions are taken to provide ventilation, together with some practical knowledge of the principle of evaporation and condensation in confined spaces. Still, it has its difficulties. Grain is from its nature a hygroscopic cargo, and includes rice, which is notoriously difficult to carry undamaged. Grain cargoes certainly have to be treated with discretion in order to preserve them without damage.

Types of damage from meteorological causes which can occur to such a homogeneous cargo include mould, or taint of the cargo due to lack of ventilation, and sweat damage, which may be caused either by lack of ventilation or even by injudicious ventilation. In addition, there can be damage due to entry of spray or fresh water through ventilators.

Sweat

Sweat in its simplest form is caused by the steel of the ship inside the hold or the cargo itself being cooler than the dew-point of the air in the hold. In the case of a hygroscopic cargo like grain, this problem is aggravated by the fact that the cargo itself, if its temperature increases, will give off moisture and increase the humidity content of the air in the hold.

During the voyage the ship may pass through a considerable range of air and

*Several of these papers have been published by the North-East Coast Institution of Engineers and Shipbuilders.

sea temperature, and indeed of humidity, and the decision as to when or when not to ventilate holds should be a major preoccupation of the master. There are few ships which have thermometers or hygrometers in their holds, and with few exceptions it is probably only Selected Ships which have hygrometers on deck. Broadly, the aim of the ship master should be to ventilate his holds if the temperature of the air in the hold approaches its dew-point, especially if the air in the vicinity of the deck-head or ships' side is likely to be below the hold dew-point or if the cargo itself is below the hold dew-point. It is probably wise as a general rule not to ventilate when the dew-point of the outside atmosphere is above that of the hold, but no hard and fast rules can be given—a lot must depend on circumstances. Of course, the master's problem is further complicated by the fact that in very bad weather it may be necessary to cover his ventilators to prevent damage by sea or spray. If the ship is going from a cold zone to a relatively warm zone, it would not matter a great deal if the ventilation was kept closed down for several days. When the air in the hold was getting a bit warm and tending to approach that of the outside atmosphere, it is true that the humidity content of the hold would probably be pretty high due to the moisture given off from the cargo. Whenever the ship had days when the outside humidity was relatively low, lots of ventilation could be given and results would probably be beneficial. Changing from a warm climate to cold, however, is the really tricky time, and is the time when ventilation should be resorted to at the earliest possible moment.

Extreme ranges

Let us now look at a few figures. The extreme air temperature ever recorded at sea, taking all oceans and all seasons into account, was a maximum of 105°F in the Persian Gulf, and a minimum of –40° in the Bering Sea off Point Belcher, but the 5–percentile extreme range* is 10°F to 95°F, and it is unlikely that a ship on any ordinary voyage would get outside this range which in itself is pretty formidable.

Diurnal range of air temperature at sea in the open ocean is small. Our Ocean Weather Ships show a range of a little under 1°F on the average. Ashore the diurnal range of air temperature is much greater; e.g. at Kew the average diurnal range for June is nearly 14°F, and on a clear summer day it has been known to be as much as 40°F. Aboard a ship the diurnal range of temperature of a steel deck may be as much as 50°F in the tropics on a clear calm day. Experiments with an unpainted block of steel ashore at Panama showed a sun temperature of 133°F when the shade temperature was 88°F. From these figures we can see the advantages of wood-sheeted decks and of awnings.

Extreme temperatures of the sea water over the whole world vary between 27°F and 96°F, the diurnal range being somewhat less than $\frac{1}{2}$°F on the average. Generally sea temperatures are found to be higher than air temperatures, the exceptions being in regions like the Grand Banks in summer and the Red Sea in spring, summer and autumn. At the boundary of the Gulf Stream and Labrador Current, where notoriously extreme conditions are found, we have a record of the air temperature falling from 57°F to –1°F in less than 12 hours, and sea temperature at the same time falling from 68° to 44°. Fairly rapid changes of sea temperature (and hence of air temperature) also occur in other local areas, e.g. Oya Siwo and Kuro Siwo, Benguela Current, Humboldt Current, etc.

The range of relative humidity in the open sea is not anything like as great as that experienced ashore. At sea the minimum varies between about 40 per cent and 70 per cent, its maximum of course being 100 per cent. Ashore, in England, the relative humidity has been known to be lower than 20 per cent, and in Egypt 2 per cent is an extreme minimum. Diurnal range of humidity at sea has not been

*The upper and lower 5–percentile temperatures are those temperatures above and below which only 5 per cent of all recorded temperatures occur; the 5–percentile extreme range is the difference between these two temperatures.

worked out, but is probably very small; at Kew the diurnal range of humidity averages 30 per cent (58 per cent to 88 per cent) in July and about 6 per cent (80 per cent to 86 per cent) in January.

A transatlantic route

Considering an extreme case to emphasise some of these figures. A ship loads grain in Halifax, N.S., in February, air temperature being 35°F, weather conditions damp and foggy. She is bound for the Cape and the meteorological conditions she experiences during her voyage would be broadly as follows.

Off Halifax: mean air 46°F, mean sea 55°F, mean relative humidity 85 per cent and minimum 42 per cent. She gets a sudden rise of temperature with relatively high humidity on crossing from the Labrador Current into the Gulf Stream, and when she approaches the Equator she will have a mean air temperature of 79°F, a mean sea temperature of 80°F, relative humidity figures being 87 per cent mean and 61 per cent minimum. Off the Cape she will have a mean air and sea of about 68°F, and mean relative humidity of 80 per cent and minimum 48 per cent.

In the cold, damp conditions prior to entering the Gulf Stream area, ventilation would be pointless. After crossing the Gulf Stream the sudden increase in outside temperature will not necessarily have any ill effect on the cargo, and it will take an appreciable time for the cargo to warm up to the outside temperature. But as its temperature increases the grain will, so to speak, breathe and give out its moisture into the atmosphere of the hold, and if there were no ventilation throughout the voyage it would inevitably become musty in the middle of the stow—and near local warm parts of the ship it might even start to grow out. It is necessary to ventilate when the dew-point outside is below that of the cargo or of the hold atmosphere, but when the outside dew-point is higher it is probably better not to ventilate.

If this ship were bound for Halifax from a tropical region, the situation on crossing from the warm Gulf Stream into the cold Labrador Current would be very different. The sudden drop in temperature both of sea and air would inevitably cause sweating at the side and deckhead of the holds and it would be essential to ventilate all holds at the earliest possible moment, so as to lower the general air temperature therein and the temperature of the cargo as soon as possible.

Mixed cargoes

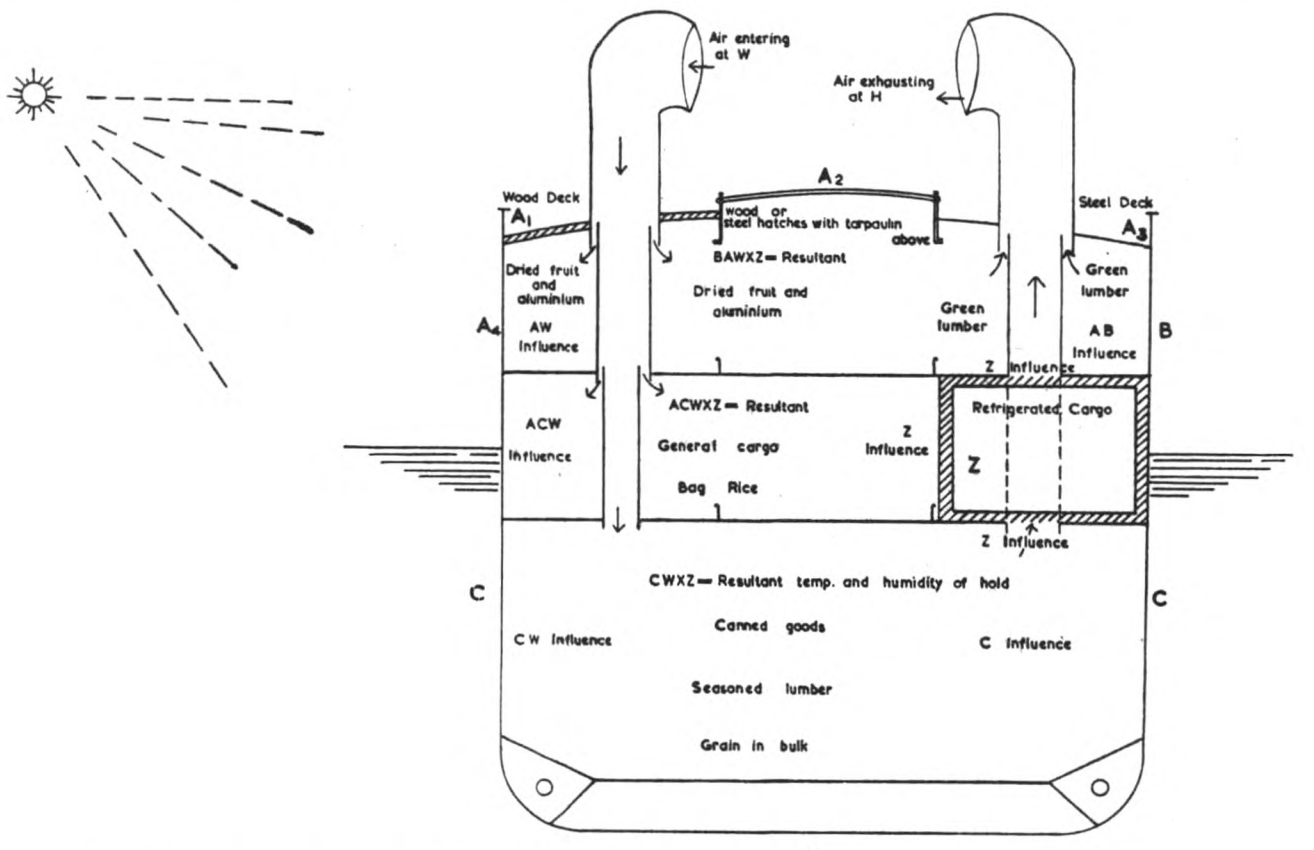
Mixed cargoes cause many more complications. A ship loading at North Pacific coast ports of North America and bound for the United Kingdom via Panama Canal, may carry grain, green lumber, dried fruit, canned goods in ordinary stowage and apples under refrigeration. We have here a complicated mixture of hygroscopic goods—grain, lumber, dried fruit—and non-hygroscopic canned goods. All have their problems: the grain and lumber contribute their quota of moisture to the hold atmosphere; ships' side and decks are sensitive to variations of outside temperature. There are areas of local heating alongside engineroom and boilers, and local cooling alongside the refrigerated chambers. Canned goods, for example, are notoriously susceptible to damage by rust, the dried fruit and the grain can be tainted or become mouldy and the damage which can occur can be made worse by injudicious use of ventilation. (See diagram opposite).

A hygroscopic cargo stowed near an engineroom bulkhead becomes heated locally and gives off moisture to the general hold atmosphere. There is plenty of fog on the Pacific coast—high humidity outside—so that during the early part of the voyage ventilation is probably unwise. All the hygroscopic cargoes give off moisture, to a varying extent, as the temperature rises slowly in the hold during the vessel's passage to the southward, and if, for example, the temperature of the canned goods and other metal goods remains low, as it may well do in the middle

of the hold, some moisture will inevitably be deposited on them. It is quite a problem to know when to start natural ventilation—warm air with high dew-point may do more harm than good, but off the coast of southern California there are plenty of days when the air is relatively dry, and ventilation can certainly be carried out then. The outside humidity should be constantly watched in association with the air and sea temperature, as well as the humidity in the hold.

Other hygroscopic cargoes which might be mentioned include jute, gunnies, wool, hides and textiles; non-hygroscopic cargoes embrace metal goods of all types, including tinplates and blackplates, both of which are particularly susceptible to moisture damage. One trouble is that so many of these goods are liable to be shipped in places where the humidity is high and rain frequent, so that the ship-master's problems begin under rather unfavourable conditions from the moment the goods are in the ship. It is extremely difficult for him to say that a certain commodity loaded under unfavourable conditions is not shipped " in apparent good order and condition ".

When a ship insulated for refrigeration is carrying a general cargo, no natural ventilation is perhaps necessary during much of the voyage, provided the cargo was loaded dry and there is not too much mixture of hygroscopic and non-hygroscopic goods. If the cargo were loaded in cold conditions, however, any metal in that cargo would tend to sweat if suddenly unloaded in a warm, damp



Schematic diagram showing midship section of a fictitious vessel loaded with a general and refrigerated cargo.

The letters indicate the influences which affect the cargo.

A1, A2, A3, A4—Surfaces exposed to sun.

B—surfaces in shade
C—surfaces exposed to sea
W—outside air
H—air in hold
X—state of cargo, e.g. dry-loaded, wet-loaded or hygroscopic.

Combinations of letters, e.g. ACWXZ indicate the factors to consider when assessing circumstances under which ventilation is required.

climate; and similarly a gradual rise of hold temperature would make the hygroscopic goods give off moisture which might cause sweat on the relatively cooler metal goods. Ventilation on nice days with low humidity would undoubtedly be wise.

Enquiries made of underwriters and cargo surveyors seem to indicate that although damage from what one might call hygroscopic causes is not enormous at the present day it is, nevertheless, fairly serious, and there is little doubt that anything which can be done to improve matters is all to the good.

Refrigerated cargoes themselves have their own meteorological problems. For example, there used to be a lot of trouble with mould on chilled meat. One wonders if the reason for the mould was the enormous amount of water sprayed on the meat in the Frigorifico prior to chilling. Lime trays were tried at one time to reduce the humidity of the chilled chamber, but the modern method is to introduce a small quantity of CO_2 gas in the chamber to kill the mould. Refrigerated fruit such as apples give off CO_2 gas, which is not only toxic to human beings but would also damage the fruit if a heavy concentration of it were not cleared from the chamber by exhaust fans at regular intervals.

Mechanical ventilation and drying

We hear quite a lot nowadays about mechanical ventilation, recirculation and artificial drying of the ventilating air, and there seems to be little doubt that such systems either on their own or jointly can do a lot to lessen damage. It is fairly obvious that if one can reduce the humidity of the air admitted into the hold, or recirculate and dry the existing air, sweat from all causes will be lessened, and many ships have adopted such systems. But to instal all the necessary ducts and trunks in the ship costs a lot of money, and the ship-owner somewhat naturally is not prepared to do this unless he is convinced that it would pay him to do so. Many modern ship-owners seem to temporise by introducing mechanical ventilation without drying; this is undoubtedly an advantage compared with ordinary cowl ventilators, as it allows a very rapid rate of ventilation when conditions are favourable, and presumably an easy means of shutting off ventilation quickly in unfavourable weather. There is much that can be done to prevent damage if the problem is approached with intelligence by the ship's officers; the best mechanical ventilation and humidifiers in the world are not much use if the officers do not fully appreciate the problem.

One rather wonders why the old cowl ventilator remains so popular—it is difficult to cover over in heavy weather, difficult to turn, and readily admits moisture (rain, spray, etc.). The rather complicated " baffle " type ventilator which we used to see so often in German ships is probably not a very good ventilator, because being designed to keep out spray and other moisture it consequently does not admit much air. It seems that the fan ventilator with its inlet well above the deck, or under cover, with some form of hinged flap or other apparatus, which can easily be operated to exclude all air or spray or rain if necessary, is the best answer

Other effects of weather

Loading and discharging in rain is always a tricky problem and inevitably the cause of much damage to cargo. In the River Plate meat trade the effects of rain and sunshine were to some extent dealt with by using tents and marquees, but this is obviously too expensive except in special cases. The meteorologists of the world do their best to provide adequate forecasts of rain, and in certain cases there is no doubt that money can be saved by avoiding cargo work when a long period of rain is confidently expected—but time is money, and turn round of ships is slow enough as it is, so it is difficult to say when such action should be taken. There are so many important ports where cargoes are liable to be damaged owing to a notoriously rainy climate, and it is very difficult to think of an answer. Tents over the hatches,

without the use of marquees, or quick-acting mechanical hatches, are perhaps a partial solution.

Other meteorological aspects of the cargo problem come to mind. The effect of rain, snow and ice and spray upon the stability and draught of a vessel loaded with timber on deck; the effect of abnormally high deck temperature upon liquids carried in drums on deck; the effect of sudden frost upon potato cargoes and the like; the unexpected delay of a ship loaded with a delicate fruit or other refrigerated cargo due to bad weather or fog; and the risks of spontaneous cumbustion with such cargoes as cotton, esparto grass and the like, if reasonable precautions about keeping the cargo dry and ventilating with discretion are not taken. Indirect meteorological aspects are numerous, and include damage to ship and cargo by ice, problems in connection with the International Load Line Areas, precautions to prevent grain and other cargoes shifting in heavy weather, and decisions as to the amount of bulk-heading or breaking down of stowage for a coastal voyage of a partially discharged ship.

Conclusion

Sometimes we hear people ask, "What is the practical use of a ship's officer learning meteorology?" It seems that here we do have a practical instance of its usefulness. There is no doubt that the officer who is meteorologically minded will be in a better position to deal intelligently with these problems, in addition to seeing that ventilators are kept properly turned off the wind in heavy weather or in rain. And whatever the ventilation system, there is no doubt that the officer's knowledge about the meteorology of the problem will be of value, especially about the temperature-humidity relationship and its effect on cargo.

It would probably be advantageous if all ships were provided with hygrometers on deck. For indicating conditions in the hold some form of distant reading psychrometer is the best answer. In a general cargo ship it might be possible to have thermometer pipes leading into the hold, such as is done with refrigerated cargoes, and to lower a special type of distant reading psychrometer operating, say, on the Bourdon tube principle, say once a day. In ships fitted with mechanical ventilation it is of course relatively easy to test the humidity of the exhaust air by a hair hygrometer or other means.

In conclusion, it is appropriate to mention that, as a result of the voluntary meteorological observations made at sea aboard hundreds of British ships during nearly 100 years, there is available a mass of statistical information about temperatures and humidities at sea which is being used to an increasing extent by shipowners, shippers and others interested in safe carriage of goods by sea; and there is no doubt that the meteorologists of all maritime countries will co-operate to the best of their ability to provide whatever help and advice they can in trying to solve some of the problems involved.

* * *

During the discussion of the paper the following additional points were brought out:

(*a*) Quite a lot of sweat is experienced with oil cargoes. If the oil tank is only partially full, sweat collects on the tankhead and falls into the oil.

(*b*) If a hold is completely full of a certain cargo, such as grain, the damage from sweat is less likely than if the hold was only partially full.

A Marked Diurnal Variation of Visibility at Sea

By H. JAMESON, D.Sc.
(formerly on the scientific staff of the Marine Branch, Meteorological Office)

In the course of investigations into the diurnal variations of various meteorological factors in a few selected areas of the North Atlantic, a marked diurnal variation of the visibility, during the months of the steady North-east Trades, December to May, was found for Marsden Square 003D (5°–10°N, 25°–30°W). The actual factor investigated was the percentage frequency of reports of either fog (f), mist (m) or haze (z) in the Beaufort notation, taken over the years for which Hollerith data were available.*

The diurnal variation of this visibility factor for square 003D is shown in Fig. 1 for the two six-monthly periods June-November and December-May, and also for each month from December to May separately. (The diurnal variation for square 003B is shown for the year as a whole.) In the curves for the periods longer

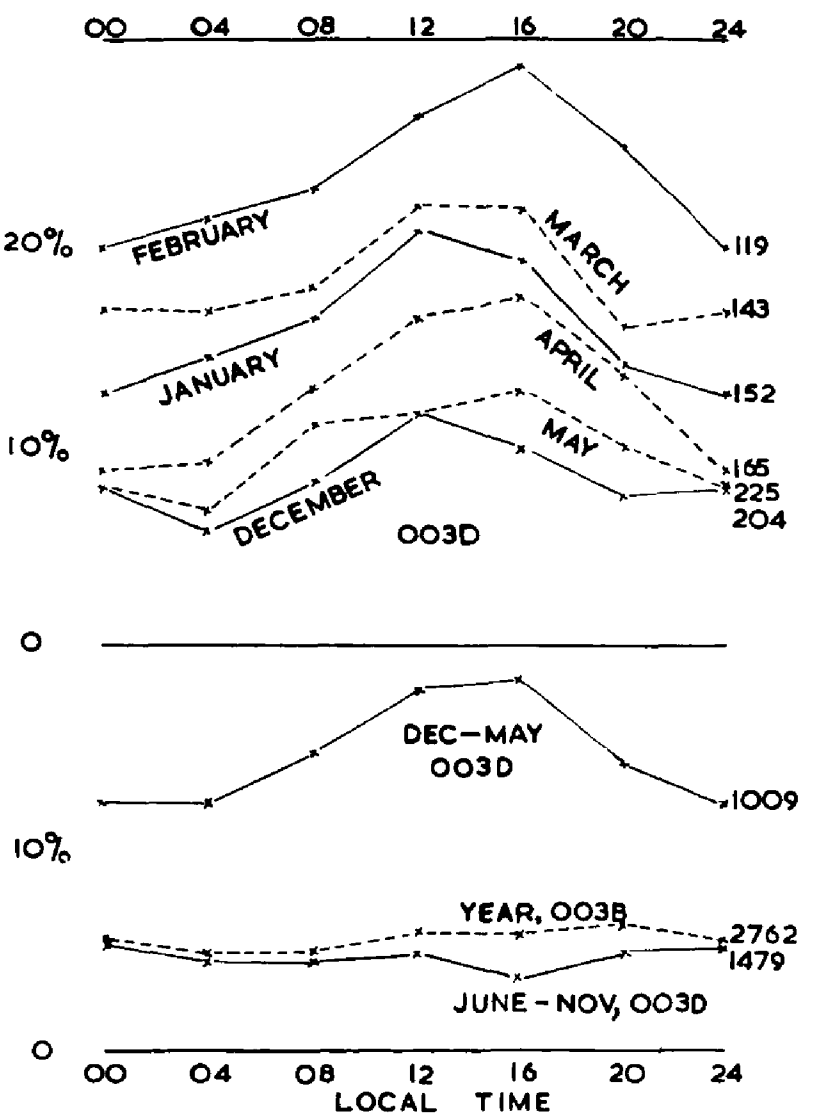


Fig. 1

Diurnal variation of the percentage frequency of poor visibility (f, m or z) in the Marsden Squares 003B and 003D.

The figures to the right of the curves show the average number of observations per watch

*For this investigation, observations recorded aboard British voluntary observing ships during the years 1854 to 1939 were used.

than a month, each month is given the same weight, irrespective of the number of observations. No diurnal variation of visibility is apparent within the period June-November. This diurnal range disappears quite suddenly between May and June and reappears between November and December; neither June or November show any trace of it.

A possible explanation of this diurnal variation might lie in the different conditions for observation between daylight and night hours. It must be more difficult to observe the occurrence of slight mist or haze during the night. However, the graph for June-November in 003D, and for the whole year in 003B, which show practically no diurnal variation (see Fig. 1), indicate that any such effect can only be small. That the frequencies for 0800 (daylight) and 2000 (night) are almost the same in the curve for 003D, December-May, is another indication of this.

Inspection of charts of poor visibility for the Atlantic Ocean* suggests that the high frequency of poor visibility for square 003D, between December and May, is due to the transport of sand from the Sahara by the North-east Trades (see Fig. 2).

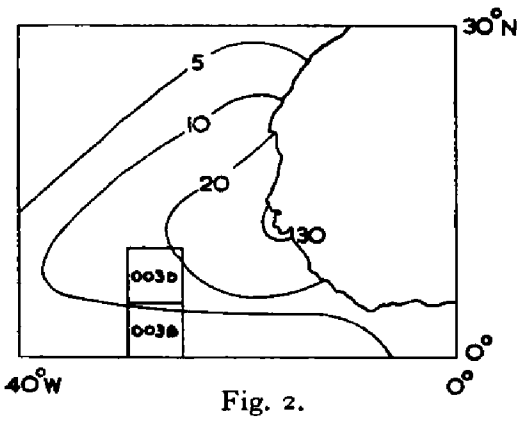


Fig. 2.

Percentage frequency of poor visibility (f, m or z) averaged over the six months December to May, off the coast of north-west Africa.

This would involve a journey of well over 700 miles over the sea. In 003D the average wind near the sea surface between December and May is about 11 knots. The mean wind effective in transporting the sand to this area may be appreciably higher than this, but even with a considerable increase in this figure, the time taken for the transport will be so long that any diurnal variation in the amount of sand transported from its source (due to a diurnal variation of wind strength or other causes) should be smoothed out before the sand-bearing winds reach 003D. The diurnal variation in the mean wind (December-May) in 003D is less than half a knot, with a maximum about 09 hours, so that the diurnal variation in the frequency of poor visibility cannot be accounted for in that way.

A possible explanation is that the sand carried along by the wind absorbs solar radiation and, becoming heated, itself heats up the neighbouring air particles, thereby causing an inversion at a comparatively low level, which will be most intense in the early afternoon. This will reduce the turbulence which normally keeps the sand particles in the air, and prevents them from falling too rapidly into the sea. The result of this reduction in the turbulence will be a greater concentration of sand particles in the layers near the sea surface, and therefore a greater frequency of poor visibility in those layers during the hours when this rise in temperature persists, apparently from shortly after sunrise to shortly after sunset.

On the other hand, radiation at night from the sand particles should cool the neighbouring air and give a steep lapse rate near the ground, which would increase the turbulence and spread the sand particles over a greater depth, thus improving the visibility near the sea surface.

The curves of poor visibility for the separate months, for December-February

*Such as those in *Monthly Meteorological Charts of the Atlantic Ocean.* M.O.483.

and March-May, and for the whole six months were harmonically analysed; in the latter cases each month was given the same weight. The oscillation was expressed as

$$a_1 \sin (t+A_1)+a_2 \sin (2t+A_2),$$

where t is measured from local midnight. The results are shown in Table 1.

The curves for the three-monthly and six-monthly periods are almost simple sine curves, while the harmonic constants for December-February and March-May agree closely.

Table 1. Results of the harmonic analysis of poor visibility in the Marsden square 003D

	24 hours		12 hours	
	Semi-amplitude	Phase	Semi-amplitude	Phase
December	2·2	244°	1·3	091°
January	4·0	261°	1·0	027°
February	4·2	229°	1·2	308°
March	3·1	253°	1·5	033°
April	4·5	235°	0·4	286°
May	2·8	238°	0·5	214°
December-February	3·4	243°	0·6	027°
March-May	3·4	242°	0·4	016°
December-May ..	3·4	242°	0·5	020°

The wind regimes in Marsden squares 003D and 003B may be summarised as follows:

(*a*) Marsden square 003D:

(i) December-May: Steady North-east Trades.

(ii) June-November: Winds comparatively inconstant, on the whole either from easterly or southerly directions, according to the months.

(*b*) Marsden square 003B:

(i) December-May: Winds comparatively inconstant, and on the whole either from NE or SE, according to the months.

(ii) June-November: Steady South-east Trades.

The lack of a marked diurnal variation of visibility in those areas and those seasons where and when there are no steady North-east Trades is additional support for the explanation suggested above.

Earthquakes in St. Kitts and Nevis

By J. C. W. WICKHAM

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The earthquakes and tremors at St. Kitts and Nevis in the West Indies during December 1950 and January 1951 have once again focused attention on this region and reminded the present generation of their heritage of volcanic disturbances which have from time to time afflicted these beautiful islands which stretch in a crescent-like curve from the Dutch island of Saba in the north to the British island of Grenada in the south.

St. Kitts (or St. Christopher's)—its Carib name was Liamuiga, or the fertile island—with justice claims the honour of being the " mother colony " of the West

Indies as it was the first island on which an English settlement was made. It was founded in 1624 by that Sir Thomas Warner who was perhaps the greatest of the early pioneers in the colonisation of the West Indies, and whose descendants (including the present Sir Pelham Warner, the famous cricketer, who was born in the West Indies) continue to have distinguished connections with these islands.

Nevis, the sister colony of St. Kitts, from which it is separated by a narrow strait two miles in width at the narrowest point, was colonised by a group of settlers sent from St. Kitts by Warner in 1628, and is of historical interest to seamen because of the fact that Admiral Lord Nelson was married there.

From the volcanic cone of Mt. Misery (3,711 ft.) in St. Kitts, which towers above a crater (now dormant) about 600 ft. deep and two-and-a-half miles in circumference at the lip, to the mountain lake of Grand Etang formed in the crater of an extinct volcano in Grenada, traces can be found of the volcanic structure of the islands. Nearly every island in the group has a " soufrière " or sulphur pit or crater in its mountains, and some of them, like Guadeloupe's La Soufrière up to this day continue to emit smoke and flame, a constant reminder that the underground fires are never entirely extinguished. On the island of Nevis there is now no well-defined crater, but there are numerous hot springs and from the top of Nevis Peak (3,596 ft.) a thermal mineral spring has been diverted down the mountainside into a bath house at a temperature of 110°F. Montserrat has a fine crater; Guadeloupe has its boiling spring and the volcano La Soufrière; Dominica has a boiling lake on the top of Morne Diablotin; Mont Pelée, perhaps the most famous of all the volcanoes in the region, is situated in Martinique, and the sulphur deposits on the tops of the twin Pitons in St. Lucia and the now dormant Soufrière in St. Vincent all give added weight to the evidence that each of these islands is little more than a volcanic mountain thrown up by the sea. Only Barbados to the east of the main chain of islands is without obvious evidence of volcanic structure.

As may be expected among islands of such obvious volcanic composition, there is an impressive catalogue of earthquakes and eruptions in this region. In 1680, Jamestown, on the west coast of Nevis, was destroyed by earthquake. Soufrière in St. Vincent gave its first evidence of violence in 1718 when lava poured from its crater. In 1812 it erupted and devastated the island. At the time of this eruption, on the same day in fact, 10,000 people lost their lives in an earthquake in the Venezuelan city of Caracas on the north coast of South America. In August, 1843, Guadeloupe had a disaster in the form of an earthquake and 5,000 lives were lost in Pointe-à-Pitre, the island's capital, while devastation extended throughout the island. In 1902 the town of St. Pierre in Martinique was completely destroyed by the eruption of Mont Pelée and some 40,000 lives were lost. Within a day of the Mont Pelée disaster 2,000 lives were lost (including the almost complete extinction of the aboriginal Caribs on the island) when Soufrière in St. Vincent erupted. In this eruption, volcanic ash spread as far as Barbados, 100 miles to the windward across the sea, and specimens of the dust can still be seen in the museums of that island. In 1907 the larger part of Kingston, the capital of Jamaica, was destroyed by " the great earthquake ", and as recently as 1928 St. Kitts experienced a shock when an earthquake which lasted for two days " resulted in death and destruction ". The most recent of these earth tremors occurred in St. Kitts and Nevis in December, 1950, and continued until the middle of January, 1951.

The Nevis correspondent of the St. Kitts-Nevis *Daily Bulletin* of the 29th December, 1950, states: " For the past few days a few slight shocks and tremors have been occurring, but on Wednesday evening (27th) one fearful shock brought most persons, panic stricken, rushing into the open. Sounds of falling glass and smashed crockery could be heard on every side . . . ". This shock followed a sequence of more than 200 tremors of varying intensity which commenced about 3 a.m. on the 27th and which rocked the island, resulting in damage to real property. Homes all over the island were deserted and their occupants slept in the open pastures

and in the streets; all large stone buildings were damaged and walls and ceilings broken, but no lives were reported lost.

In St. Kitts the most severe shock was experienced at 4.10 p.m. of the 29th, when the people of Basseterre, the capital of the island, were suddenly thrown into a state of excitement when they saw buildings swaying to and fro. " Never before ", states a newspaper report of the 30th, " in any period of our history has so much anxiety been experienced in this island . . . last night many people slept in the open and in cars. The tremors continued up to this morning. The 'quakes have now reached the alarming stage ".

It would appear that the tremor of 4.10 p.m. of the 29th was the most violent of all in both islands. In Nevis it was reported that, at that time, the earthquakes seemed to burst upon the island with redoubled fury, far worse than the shock of the 27th. Nevis shook from end to end, and up to the 30th there was a continuous sequence of 'quakes and tremors. During this most severe shock the girls' school was practically destroyed, the west wall of the Court House collapsed, as did the walls of the Public Library, and a newspaper report of the 30th states ruefully that " one more shock like that of 4.10 p.m. yesterday and very few buildings will be left standing ".

By 4th January, 1951, it became noticeable that the intensity of the earthquakes had decreased to slight tremors, and the newspaper reports of that date reflect the easing of the tension which the population of the islands had begun to feel. An article on the 5th commented on the exaggerated reports of destruction and damage which had leaked through to the outside world, and points out that though the islands had passed through a nerve-wracking nine days, no major disaster was suffered as some reports indicated. By the 6th the Nevis correspondent of the daily newspaper could write that the situation was becoming " more normal ", the shocks lessening in intensity to about 20 in each 24 hours, although a violent shock lasting 30 seconds gave renewed cause for fear.

Up to 14th January moderate shocks were still being felt in St. Kitts, and the historians of the islands saw a repetition of the year 1797, when a succession of earthquake shocks, sometimes as frequent as 100 in 24 hours, occurred for several months. This earthquake of 1797 was said to be the outer edge of the tremendous convulsions which took place that year in Ecuador and which caused a loss of 41,000 lives. In this connection it is interesting to note that four lives were lost and 11 people injured in earthquakes which caused extensive damage in Peru and Ecuador during the first half of December, 1950, and that as recently as 8th May, 1951, 1,000 people were killed and 25,000 rendered homeless in the earthquakes at Salvador in Central America.

It seems beyond doubt that Nevis was the worse sufferer of the two islands. The damage in St. Kitts seems to have been confined to cracked walls of buildings and was slight in comparison to the damage in Nevis, which was estimated at $250,000. It is interesting to note that none of the wooden houses on the islands was damaged.

On 15th February, 1951, the Administration of the islands issued a preliminary report made by a seismologist who carried out an inspection of the damaged stone buildings on Nevis, and this report seems to confirm that the earthquake of 29th December was the most severe. The effects of the Friday (29th December) tremor, the report states, indicated that its origin was about ten miles from the nearest point of Nevis and was probably under the sea to the west or south-west. This conclusion appears to be confirmed by a report from the Northern District of St. Kitts that only slight tremors were experienced there. In addition to the seismic investigation, reports of gas vents and hot springs were followed up and Nevis Peak was climbed up to a point from which the interior of the old crater could be viewed. Only very mild activity was found, much less even than on Montserrat, but investigations are being continued.

Observations on Whales from Ships

By N. A. MACKINTOSH, C.B.E., D.Sc.
(Deputy Director of the National Institute of Oceanography)

The Meteorological Office has kindly offered to co-operate with the National Institute of Oceanography in the collection of records of whales and other Cetacea observed at sea, and the Institute will be most grateful to mariners who are willing to make the necessary observations. Such observations are needed as part of a plan of research on the general distribution of whales, and detailed notes on the Institute's requirements, and instructions on methods, will be distributed through the Meteorological Office to voluntary observers. Forms for recording the observations will also be supplied.

Research on the natural history of whales has been carried on for a number of years by the " *Discovery* Investigations ", formerly under the Colonial Office but now included in the National Institute of Oceanography under the Admiralty. A practical object of this research is to assist the international regulation of whaling and conservation of the stock. Existing knowledge of the world distribution of whales is inadequate, and it is hoped that, if records of the positions and dates of whales seen are collected from a large number of ships, a good deal of new information will be gained which could not be acquired by other methods.

Whales belong to the mammalian order Cetacea, which includes also the dolphins and porpoises. Information is needed especially on the large whales, of which the most important are the Blue, Fin, Humpback and Sperm, but observations on the medium-sized species, such as the Pilot whale, Narwhal, Killer, etc., and on the dolphins and porpoises will also be welcomed.

Information required

The main requirement is to note any whales seen, with a record of the position, date and ship's time, an opinion as to whether the whales were large, medium or small, and an estimate (however rough) of the actual number of whales seen at any one time. If the species can be distinguished it should also be recorded, but this is generally very difficult, even with expert knowledge. Information is also required as to those parts of a ship's route along which whales were apparently absent. Negative observations are nearly as valuable as positive observations, and for this reason it is of some importance that the observations should be made according to a consistent plan during a voyage, so that the number of whales seen from time to time is roughly proportional to the number of whales actually present at different points on the ship's track.

Notes describing the whales, their behaviour, direction of movement, number in a school, etc., will be welcome but are of secondary importance.

Generally it will be sufficient for those on the bridge to keep an eye open at all times for Cetacea, to record particulars of any that are seen, and to supply some information as to conditions of visibility, etc., during the voyage. In certain regions, however, where observations are specially important, it is considered worthwhile to keep a daily log in which positive and negative observations are more fully recorded.

Species of whales

There are two groups of Cetacea: the *Mystacoceti*, which are the " baleen " or whalebone whales, and the *Odontoceti*, or toothed whales.

The baleen whales include most of the large species. Instead of teeth they have several hundred horny plates in the mouth which are used for straining off the small shrimp-like crustaceans (or occasionally fish) on which they feed. They are seen mostly in cold waters, but tend to migrate to warmer and even tropical waters in winter. The principal species are as follows:

BLUE WHALE: the largest of all known animals. Maximum length about 100 ft. Small dorsal fin; colour a mottled dark bluish-grey. Widely distributed, but mainly in cold waters.

FIN WHALE: maximum length 80–85 ft. Plain bluish-grey above and white beneath. Dorsal fin slightly larger than in Blue whale. The commonest large whale. Distribution similar to Blue whale.

SEI WHALE: very similar to Fin whale but smaller (maximum length about 60 ft.) and white ventral area less extensive. Distribution not well known, but avoids the coldest waters.

MINKE OR LESSER RORQUAL: seldom exceeds 30 ft. Same build as Fin and Sei whale but has a white band on flipper. Widely distributed.

HUMPBACK: maximum length about 60 ft. Stouter build, very long flippers. Relatively plentiful in some parts of both hemispheres.

In addition there are several species of RIGHT WHALES, which were hunted by the old whalers but are now scarce; and the GREY WHALE which is also scarce now, and is confined to the North Pacific.

The toothed whales include only one large species, the SPERM WHALE, but there are far more species of toothed than of baleen whales, for the group includes not only a number of medium-sized whales such as the BOTTLENOSE, GRAMPUS (or KILLER), NARWHAL, PILOT WHALE, etc., but also all the dolphins and porpoises, and of these there is a considerable variety. Many of them are very imperfectly known.

The Sperm whale grows to a maximum length of about 60 ft. It has a massive, barrel-shaped head and rounded dorsal fin. It feeds mainly on squid, and there are 18 to 28 teeth on either side of the lower jaw. It has the peculiarity of spouting at an oblique angle. Whereas the baleen whales are mainly inhabitants of cold or even polar waters, the main herds of Sperm whales live in the tropical or sub-tropical seas, though adult males are not uncommon in cold waters.

Further particulars of observations

It is not always easy to make accurate observations on whales, and the following are some points which need attention.

When large whales are observed it is often only the spout that is seen, and this looks something like a quick puff of smoke which may linger for a few seconds, the duration depending however on the size of the whale and on the prevailing wind force, the visibility and conditions of humidity. The spout is visible at several miles in good conditions, especially against a bright sky over a clear horizon. The smaller Cetacea are generally seen when the body breaks surface; the spout is hardly noticeable.

When more than one whale is in sight of the ship it is important to make some estimate of the actual number. Usually large whales are seen singly, or in small numbers which are easily counted, but there is a risk of counting the same whale or whales more than once, especially if they are moving in the same direction as the ship. This risk cannot always be avoided, but it should be remembered that most large whales usually blow several times in quick succession (at intervals of about 5–20 seconds) and then dive for several minutes. Sometimes, however, they will blow at more regular intervals for a long time, especially if they are " on passage " or scared. Sperm whales may blow 20 to 40 times and then disappear for half-an-hour or more. A school of whales generally blow more or less together and dive (or " sound ") together. By watching the whales' movements one can generally guess whether it is the same or a different whale or school which may be seen later.

It is seldom possible to ascertain the direction of movement unless the body and dorsal fin are clearly seen. The spout can be very deceptive; for example, if a whale is swimming down wind the spout may be carried ahead of it and appear as if the whale were swimming up wind.

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LIGHTHOUSES OF THE BRITISH ISLES

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St. Tudwal's islands, east and west, are situated in the northern part of Cardigan Bay. The roadstead is used as a temporary refuge for vessels during westerly or northerly gales but with winds from other directions it is exposed to a heavy sea. Near the middle of West island, the lighthouse, a white circular tower 35 ft. in height, shows a white and red sector light flashing every 20 seconds from a height of 151 ft. above sea level. The light is unwatched.

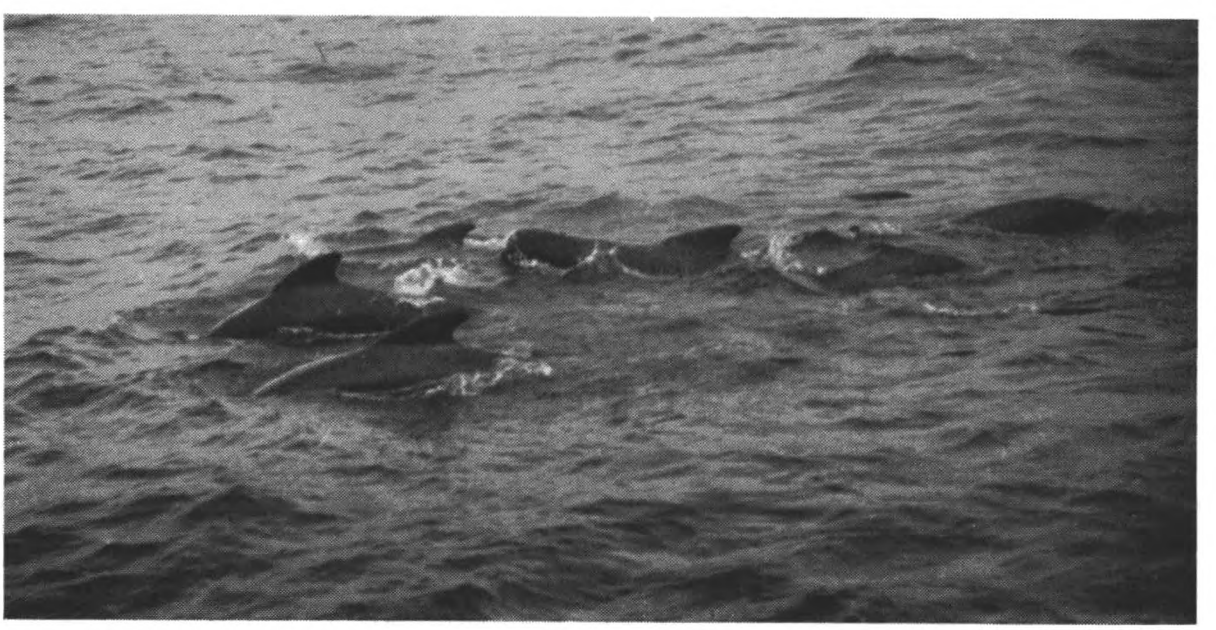

Photo by D. Philips

Pilot whales "playing" around O.W.S. *Weather Explorer* at ocean weather station ITEM on 25th August, 1950. The Pilot whale, also known as Black fish, is a large, round-headed cetacean of the family Delphinidae, resembling a porpoise in form but larger than most dolphins, sometimes exceeding 20 ft. in length. It is timid and inoffensive, feeding on small fish, molluscs and cephalopods.

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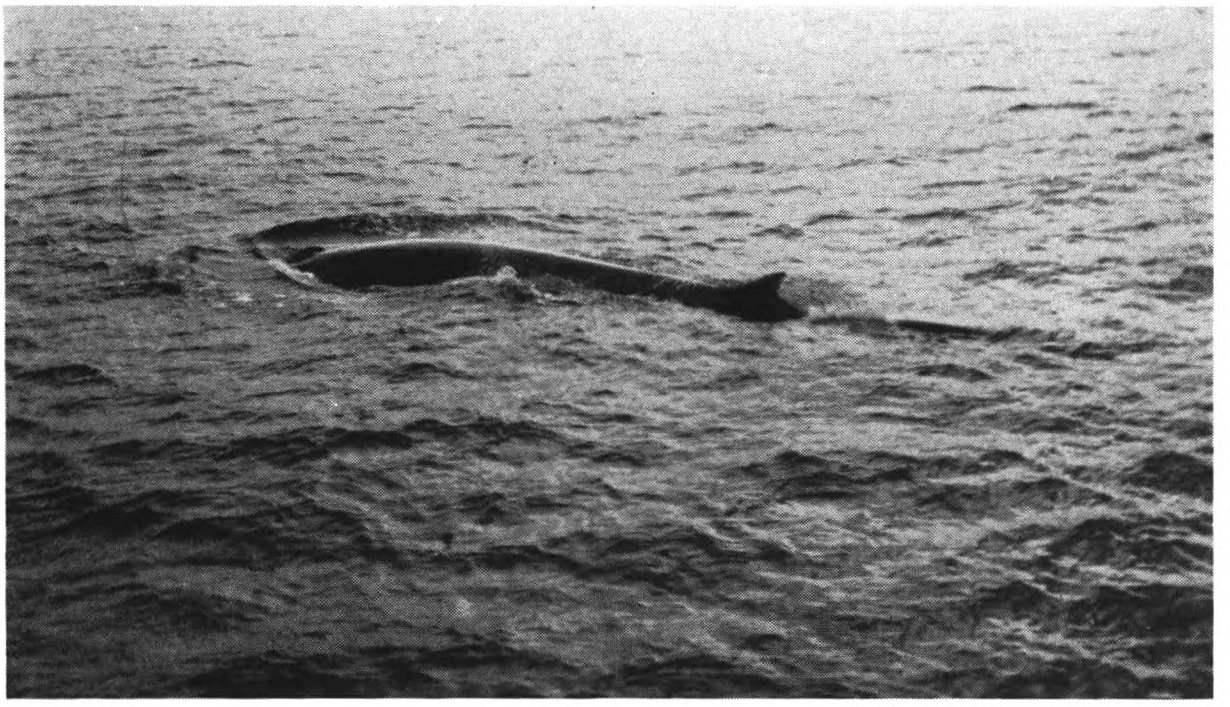


National Institute of Oceanography

A Fin whale at close quarters, immediately after spouting. As the dorsal fin appears the head is submerged but the blowholes (nostrils) are seen to be still open as the whale breathes in. See fig. 1 opposite which shows the breathing stage a few seconds earlier.

National Institute of Oceanography

A 90 ft. Blue whale on the flensing platform of an Antarctic whaling station. The lower jaw is slightly displaced.

SPOUTING WHALES

Whales must break surface periodically to breathe, and as soon as the blowhole leaves the water the breath is expelled as a visible cloud of vapour. The three species below are drawn to scale, and the part of the body above the waterline is shown in black.

Fig. 1
Fin whale (Blue whale similar but larger, Sei and Lesser Rorqual similar but smaller)

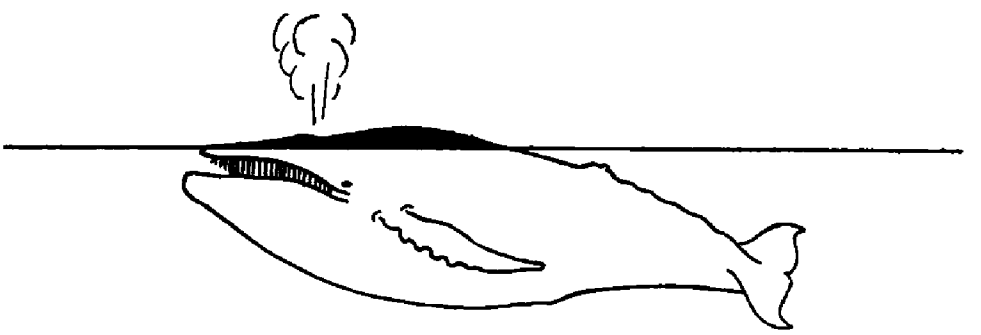


Fig. 2
Humpback whale

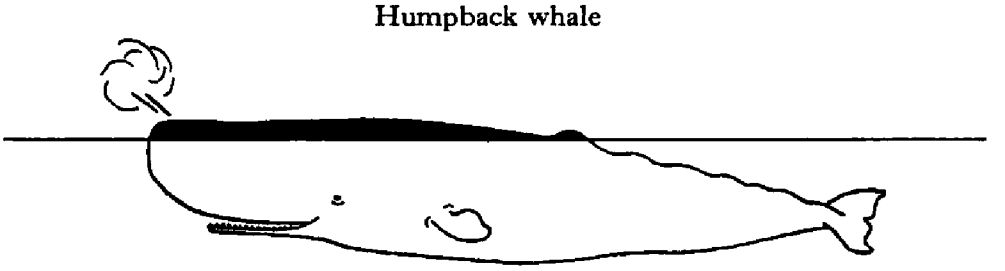


Fig. 3
Sperm whale. Note the oblique spout

Observations are of course, more valuable if the species is recognised but many of the species are difficult or impossible to distinguish. A Sperm whale may be recognised by its blunt snout which, during regular emergences on passage, is projected clear of the water, like the prow of a ship (see Fig. 3). Its spout is brief in duration and characteristically low and bushy, unlike the taller, more conical spout of large baleen whales. The Sperm whale also spouts obliquely, which no other whale does. A Humpback can sometimes be identified, though less easily, by the blunt, indistinct dorsal fin, or with more certainty if the long, knobbed flippers are clearly seen. The Rorquals, however, i.e. the Blue, Fin, Sei and Lesser Rorqual, can only be distinguished from one another by subtle differences, and their colour is totally unreliable, except that a Blue whale can sometimes be recognised if close enough for the rather faintly mottled pattern on the skin to be seen.

Cetacea can generally be distinguished as large, medium or small, and if the species cannot be positively identified it is important to note, if possible, whether a whale seen was one of the large ones or not. It is notoriously difficult to judge the size of any object in the water unless it is very close to the ship, but the size of a whale is roughly proportional to the length of time its back is exposed when it breaks surface to breathe (i.e. to blow). Thus a dolphin is exposed for not more

and usually less than a second, but part of the head, back or tail of, for instance, a Fin whale is exposed for about three to seven seconds according to whether it is swimming fast or slowly. Large whales generally give an impression of a more leisurely movement than smaller ones. The spout is also helpful. If it remains visible for more than a second or so it can be taken as fairly certain that the whale is a large one. The spout of a Sperm whale, however, may disappear rather quickly.

A large whale accompanied by a smaller one is probably a mother and calf and records of their occurrence are useful.

Any notes on the behaviour of whales may be valuable, e.g. whether swimming fast or slowly, whether changing direction frequently, etc. Little is known of the breeding habits, and precise descriptions of pairing, birth of calf, method of suckling, behaviour of mother with new-born calf, etc., would also be valuable. Whales sometimes perform antics such as jumping clear of the water or slapping the surface with a flipper, and such things are worth noting.

Regions in which observations are most needed

Records of Cetacea observed in all seas are of value, since the main object is to build up a world-wide picture of their distribution. For instance, very little is known of the distribution of Sperm whales. Widespread and more or less comparable records are needed of their occurrence and their absence, especially in tropical and sub-tropical waters. For the smaller Cetacea also no particular regions need be specified and it need only be said that observations are more valuable in waters seldom visited, although records are always useful even on the frequented routes.

There are some regions, however, where records may help to solve certain special problems. For example, observations might be of much value in the open expanses of the South Atlantic and Indian Oceans in the southern winter south of about 15°S, though few shipping routes cross these regions. The point is that the greatest populations of whales in the world (mainly Fin and Blue whales) are found in summer in the Antarctic (approximately November-April), but it is not known where they go in winter, except that there is evidence of a general tendency to migrate into warmer waters. They may become widely dispersed, but there have been occasional reports of considerable numbers of unidentified whales in sub-tropical or temperate latitudes in winter, which suggest that they may sometimes move in herds. Corresponding latitudes in the South Pacific are also important, but whales are likely to be rather scarcer there.

Humpbacks in winter are known to concentrate in tropical coastal waters off the coasts of the southern continents, but it would be useful to know further details, such as how far from the coast the majority are to be seen. The winter is also the breeding season, and observations might be made on breeding habits. Humpbacks are most likely to be seen off southern tropical coasts from June to September.

Observations in Arctic and sub-Arctic waters in summer may help towards a rough comparison of the relative density of the Arctic and Antarctic populations. A good many observations have already been made in the Antarctic, but comparable records are needed from the Arctic.

Finally it may be said that on most routes a ship is likely to see few whales (apart from dolphins) or none at all. It should be emphasised, however, firstly that a report of only a single whale seen during a voyage is valuable if many ships are making observations, and secondly, that even reports of " no whales seen " are of distinct importance provided an assurance can be given that a fairly constant lookout was kept over a specified distance.

* * *

Captains and officers of British ships who, after reading this article, would be willing to make observations of whales are requested to get in touch with the Port Meteorological Officers at London, Liverpool, Glasgow, Cardiff or Southampton for further information, and for the necessary forms for recording observations.

Summary of Weather and Currents at the Original Ocean Weather Stations "Item" and "Jig"

By A. H. GORDON, M.S., and E. W. BARLOW, B.Sc.
(Marine Branch, Meteorological Office)

Weather

On 25th March, 1950, as a result of the second International Civil Aviation Organisation Conference on North Atlantic ocean weather stations (London, 1949), the British Ocean Weather Ships took up slightly different positions from those which they had previously occupied. Station JIG, previously at 53° 50'N, 18° 40'W, became 52° 30'N, 20° 00'W, while station ITEM, previously at 60° 00'N, 20° 00'W, became 59° 00'N, 19° 00'W. Because of this change in position it seemed desirable to summarise briefly the weather conditions experienced at the original stations for the period during which they were occupied. This summary has taken the form of graphs and tables showing the mean values of various meteorological elements for each month of the period 1947–1950 for which observations are available at each of the two stations. Station JIG was first occupied in August, 1947, and station ITEM during the following month. Curves representing the variation from month to month of the mean values of the various meteorological elements for each separate year and station have been included together on the same graph. Thus the variations are readily comparable from month to month, year to year and station with station. Due to insufficient observations some of the values for ITEM for 1947 have been omitted.

Although the period covered is short, these climatological summaries are the first of their kind. It has never before been possible to prepare a summary representing a continuous climatic record for a fixed position in the open ocean.

There are seven graphs which represent the variation of the following mean monthly values:

Fig. 1. Mean air temperature
Fig. 2. Extreme maximum and minimum air temperatures
Fig. 3. Mean daily range of air temperatures
Fig. 4. Mean sea temperatures
Fig. 5. Mean air-minus-sea temperatures
Fig. 6. Mean pressures
Fig. 7. Mean wind speeds.

Three tables are included which illustrate the following:

Table 1. Occasions of winds of force 10 and over
Table 2. Mean monthly percentage frequency of visibilities
Table 3. Months of maximum frequency of each visibility.

The graphs are self-explanatory and do not require much discussion.

Fig. 1 shows that the mean air temperatures do not show much variation for the different years. At JIG the mean monthly temperature ranged from 45·1°F in February, 1950, to 57·8°F in August, 1948. At ITEM it ranged from 40·2°F in February, 1950, to 53·5°F in August, 1948. It is interesting that the extreme mean monthly temperatures for the period occurred during identical months for both stations.

The extreme individual temperatures as shown in Fig. 2, varied from 34·9°F in January, 1950, to 65·5°F in August, 1949, at JIG, and from 28·0°F in December, 1949, to 61·0°F in May and August, 1948, at ITEM. The maximum values were probably influenced by the effect of heating of the ship itself and cannot be regarded as wholly representative of the temperature of the air over the ocean.

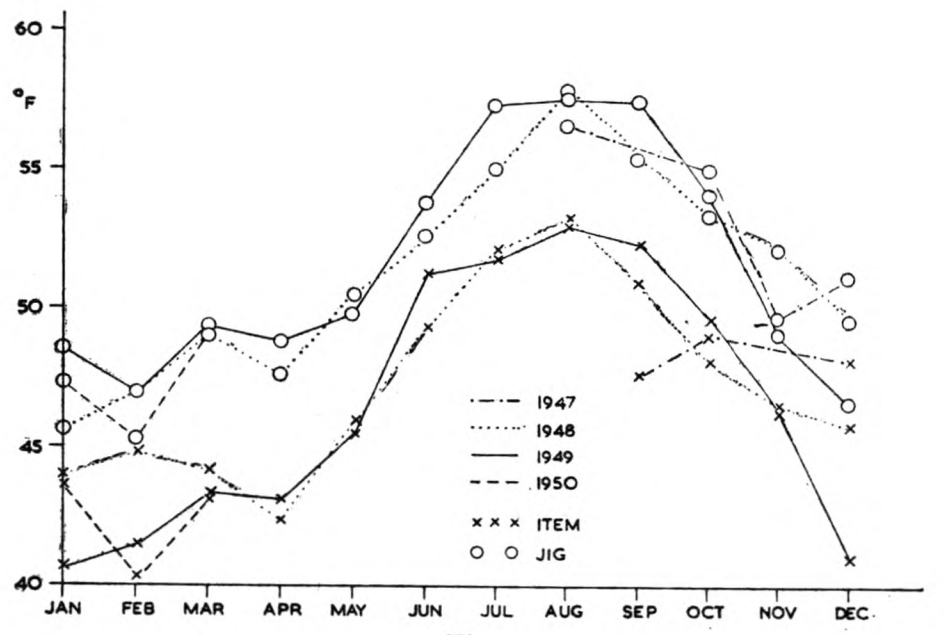


Fig. 1
Mean air temperatures

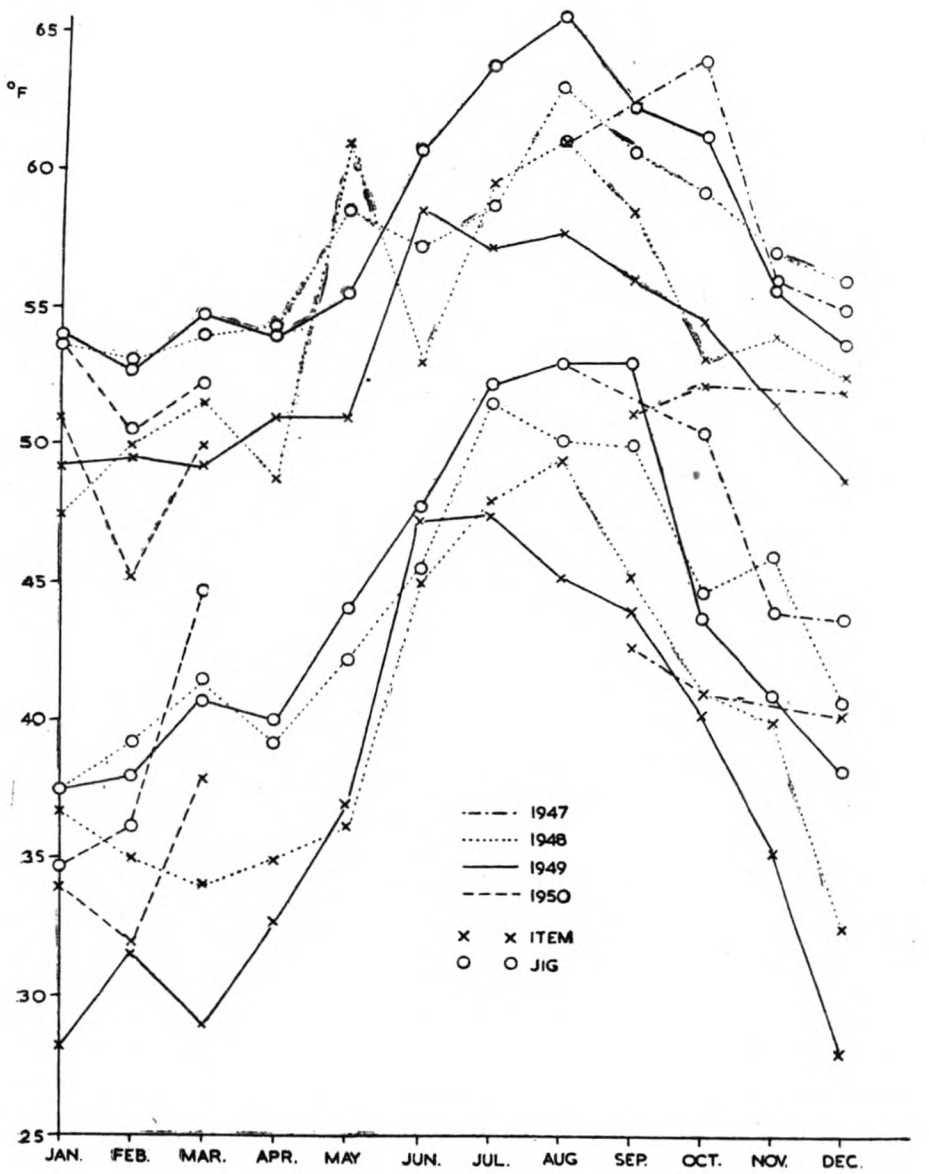


Fig. 2
Extreme maximum and minimum air temperatures.

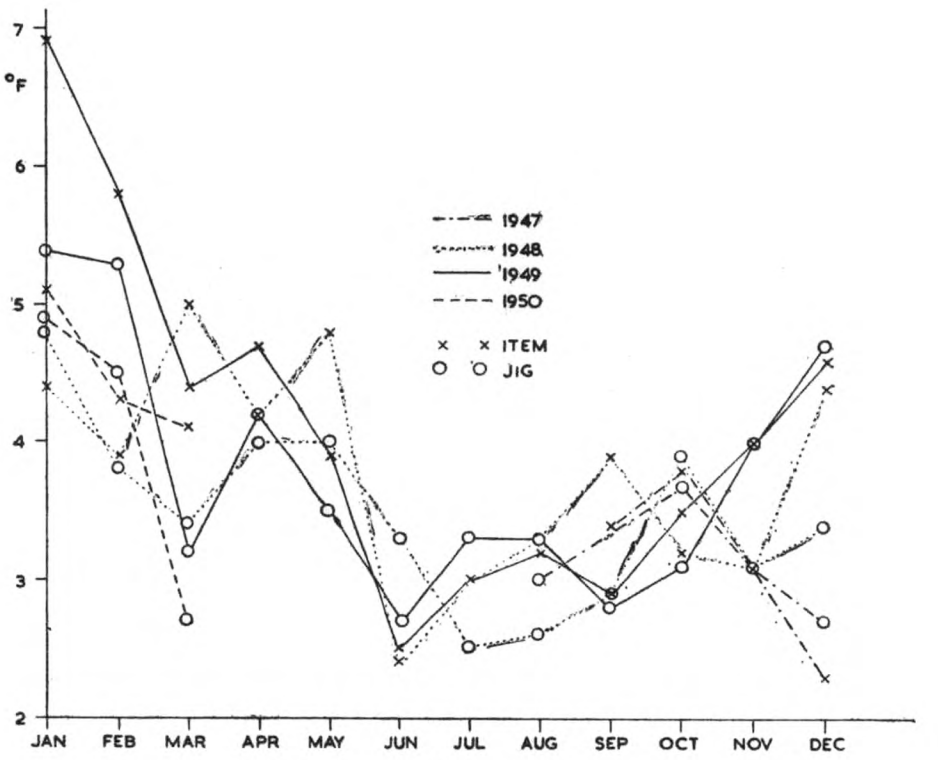


Fig. 3
Mean daily range of air temperatures.

The mean daily range of air temperature varied from 6·9°F in January, 1949, at ITEM to 2·3°F in December, 1947, also at ITEM. An interesting feature is that the mean range of temperature shown in Fig 3 is considerably greater in winter than in summer. This may be explained by the greater frequency of sharply defined frontal passages in winter than in summer.

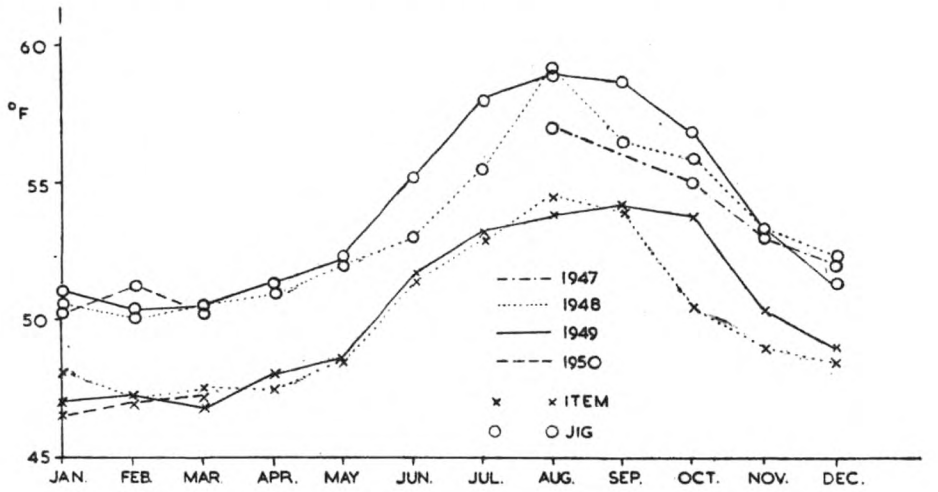


Fig. 4
Mean sea temperatures.

The mean monthly sea temperatures varied from 50·0°F in February, 1948, to 59·0°F in August, 1948, at JIG, and from 46·5°F in January, 1950, to 54·5°F in August, 1948, at ITEM (Fig. 4). Mean sea temperatures were rather lower at JIG during the cool wet summer that occurred over the British Isles in 1948 than during the warm dry one of 1949. However, it is more probable that the warmth over the Continent during that summer caused higher sea temperatures at JIG than vice versa. The mean daily range of sea temperature was only a fraction of a degree.

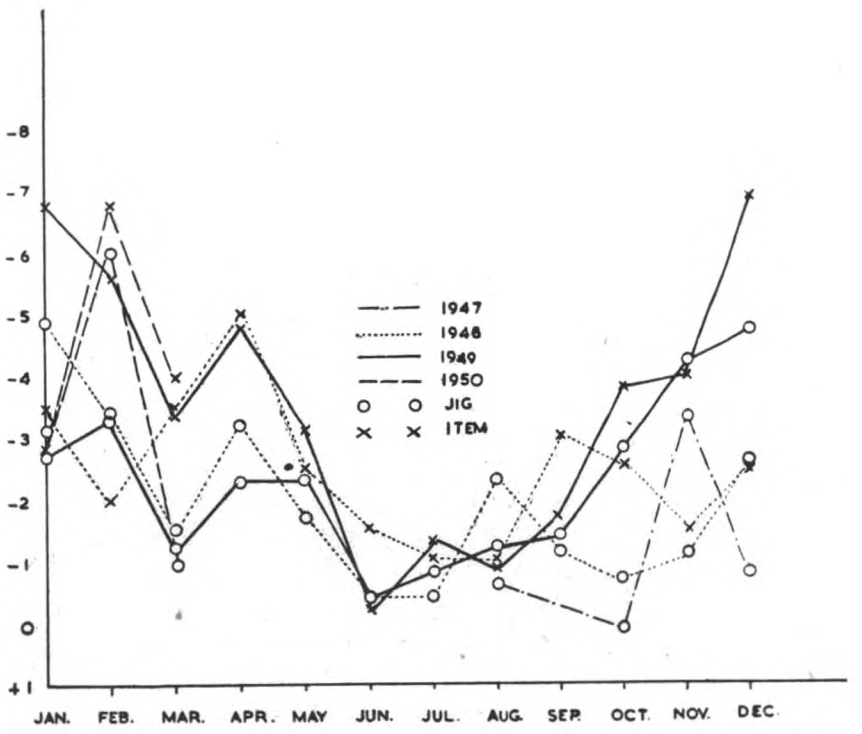


Fig. 5
Mean air-minus-sea temperatures (°F)

The difference between mean air and mean sea temperature shown in Fig. 5 indicates that the sea is much warmer than the air in winter than in summer at both stations. The mean air-sea difference ranged from +0·1°F in October, 1947, to −6·0°F in February, 1950, at JIG, and from −0·2°F in June, 1949, to −7·9°F in December, 1949, at ITEM. October, 1947, at JIG was the only month at either station when the mean sea temperature was colder than the mean air temperature.

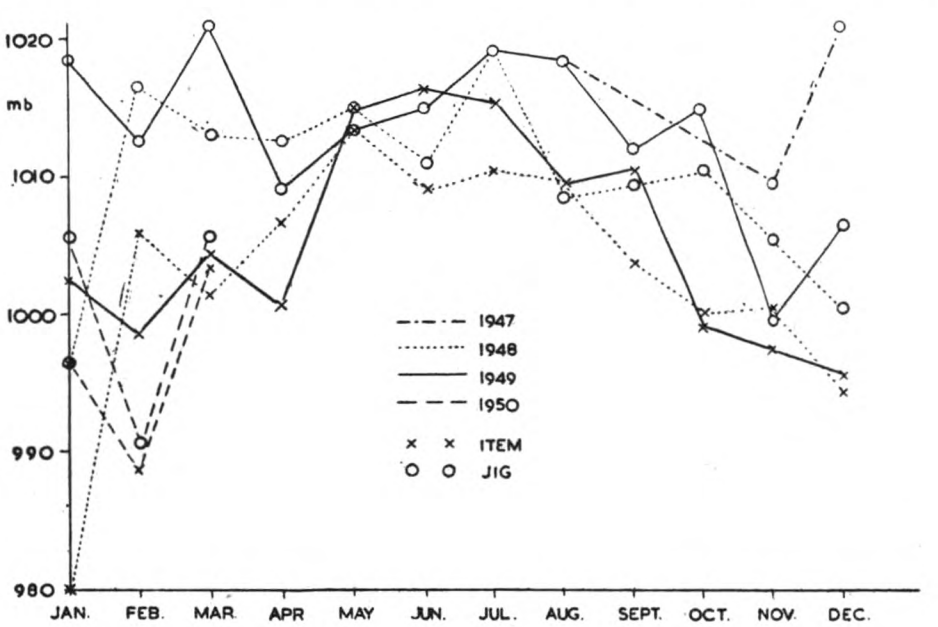


Fig. 6
Mean pressures

Fig. 6 shows that mean pressure varied from 980 mb. in January, 1948, at ITEM to 1021 mb. in March, 1949, and December, 1947, at JIG. Pressure was higher at JIG than ITEM throughout the period except in August, 1948, and May and June, 1949.

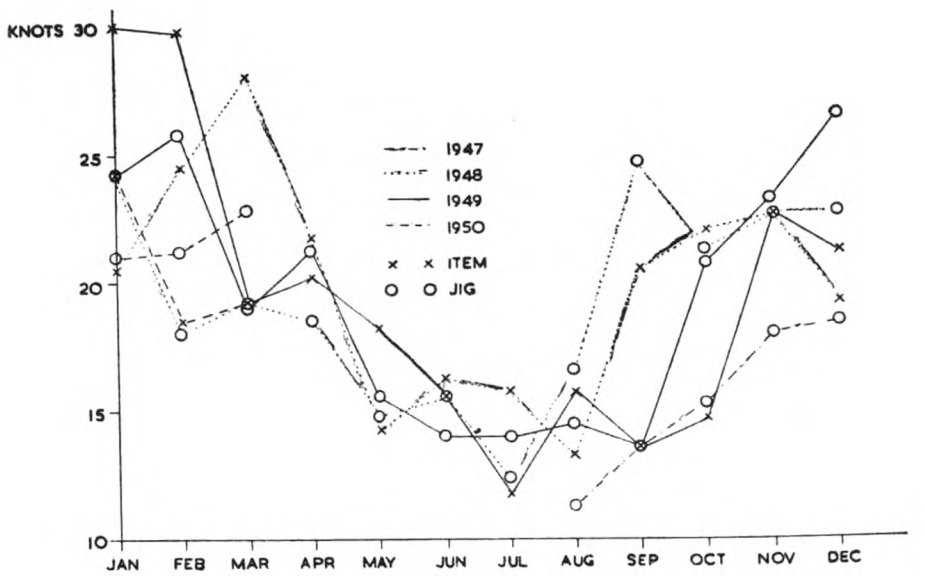


Fig. 7
Mean wind speeds.

Mean monthly wind speeds are shown in Fig. 7. The extreme mean monthly wind speed varied from 30 knots in January, 1949, at ITEM to 11 knots in August, 1947, at JIG. On the whole, mean wind speed is highest in winter and reaches a minimum in July. Table 1 gives the number of occasions on which strong winds of Beaufort forces 10, 11 and 12 occurred, for different directions.

Table 1. Number of occasions on which winds of Beaufort force 10, 11 and 12 occurred, reported for different directions

Direction (points)	ITEM			JIG		
	Force			Force		
	10	11	12	10	11	12
1– 4	2	0	0	0	0	0
5– 8	2	0	0	0	0	0
9–12	3	1	1	1	0	0
13–16	3	3	0	5	0	2
17–20	5	1	0	11	2	0
21–24	28	9	2	12	3	0
25–28	5	0	0	14	1	1
29–32	2	0	0	0	0	0

The mean monthly percentage frequencies of visibility are given in Table 2. The individual months in which the maximum frequency of each range of visibility occurred are given in Table 3.

It is seen that these maximum percentage frequencies compare fairly closely with one another for each station. Maximum frequencies of poor and moderate visibility occur from June to October. Other ranges of visibility appear to be distributed fairly evenly throughout the year.

The period covered by this summary is too short to enable a " climate " of the two stations to be determined from the available data. However, interesting information regarding the type of weather that may be expected throughout the year may be obtained from the summary.

Table 2. Mean monthly percentage frequency of visibility.

Range of visibilities	January						February						March						April				May				June			
	JIG			ITEM			JIG			ITEM			JIG			ITEM			JIG		ITEM		JIG		ITEM		JIG		ITEM	
	1948	1949	1950	1948	1949	1950	1948	1949	1950	1948	1949	1950	1948	1949	1950	1948	1949	1950	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
0–50 yd.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50–200 yd.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	5
200–500 yd.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	1	1	5	0	2
500–1,000 yd.	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2	0	0	1	4	0	1	3
1,000 yd.–1 n. mile	0	2	0	0	1	0	0	1	0	6	3	0	3	0	1	0	0	0	0	0	1	1	2	0	1	1	1	3	3	8
1–2 n. miles	3	4	1	2	5	1	2	1	0	7	4	0	2	2	1	9	2	0	1	2	4	5	5	2	6	2	5	5	10	6
2–5 n. miles	17	10	19	10	13	12	22	14	5	12	14	7	26	10	13	40	25	9	14	15	10	12	19	5	14	14	12	19	11	25
5–10 n. miles	45	37	26	9	42	24	65	39	22	37	42	15	37	40	30	28	30	11	42	37	34	28	31	17	30	20	33	34	27	29
10–25 n. miles	31	40	49	62	37	60	11	45	70	34	37	68	31	46	48	23	41	75	40	46	48	44	30	72	40	60	37	29	42	18
Over 25 n. miles	4	7	5	17	1	3	0	0	3	4	0	10	0	1	7	0	2	5	3	0	3	9	8	4	9	1	7	4	6	4

Range of visibilities	July				August				September				October					November					December				
	JIG		ITEM		JIG		ITEM		JIG		ITEM		JIG			ITEM		JIG		ITEM			JIG			ITEM	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949	1947	1948	1949	1948	1949	1947	1948	1949	1948	1949	1947	1948	1949	1948	1949
0–50 yd.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50–200 yd.	0	1	0	1	0	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200–500 yd.	0	2	0	2	0	1	2	1	3	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
500–1,000 yd.	1	3	0	3	0	1	0	4	1	2	2	1	4	2	0	1	2	0	1	0	0	0	1	0	0	0	0
1,000 yd.–1 n. mile	2	2	5	2	3	2	0	2	4	2	1	2	6	5	0	1	1	1	2	0	3	0	2	2	0	2	0
1–2 n. miles	6	5	4	2	6	2	0	5	9	2	3	1	15	3	1	2	4	7	7	1	6	3	12	1	2	3	0
2–5 n. miles	15	9	11	11	14	12	6	9	10	15	17	9	14	11	8	8	13	12	31	4	17	10	9	11	19	13	8
5–10 n. miles	30	27	25	40	29	19	25	16	37	30	19	20	32	21	19	23	24	33	33	30	26	22	44	38	29	47	21
10–25 n. miles	46	51	52	37	46	42	64	48	34	40	46	64	26	53	70	65	53	38	24	60	46	48	23	48	49	33	66
Over 25 n. miles	0	0	3	2	2	17	3	15	2	9	12	1	2	4	2	0	3	8	2	5	2	17	9	0	1	2	5

Table 3. Months of maximum frequency of each range of visibility.

Range of Visibility	Maximum Percentage Frequency		Month	
	JIG	ITEM	JIG	ITEM
0–50 yd.	1	0	October, 1947	
50–100 yd.	4	5	August, 1949	June, 1949
200–500 yd.	5	2	June, 1949	June, July, 1949 / August, 1948
500–1,000 yd. ..	4	4	October, 1947 / June, 1948	August, 1949
1,000 yd.–1 n. mile ..	6	8	October, 1947	June, 1949
1–2 n. miles	15	10	August, 1947 / October, 1947	June, 1948
2–5 n. miles.. ..	30	40	August, 1947	March, 1948
5–10 n. miles ..	65	42	February, 1948	January, 1949 / February, 1949
10–25 n. miles ..	72	75	May, 1949	March, 1950
Over 25 n. miles ..	17	17	August, 1949	January, 1948 / November, 1949

Currents

Both these stations are situated within the region of the North Atlantic Current, on the eastern side of the ocean. This current is an extension of the Gulf Stream and is considered to originate immediately eastward of the Great Bank of Newfoundland, where the Gulf Stream fans out to proceed in a general north-easterly direction across the ocean. The North Atlantic Current is mainly produced by the tractive force of the wind, and as the winds of this part of the ocean are very variable, the directions and rates of individual currents observed will also be very variable. The current in the long run, as part of the general circulation of the North Atlantic, is therefore the residual current produced by the excess of the predominating wind over the other winds.

The variability of the North Atlantic Current is well shown by the roses given for each quarter of the year in M.O.466, *Quarterly Surface Current Charts of the Atlantic Ocean*. The observations used in making this atlas were those of merchant ships, which while fairly numerous in the lower latitudes of the eastern part of the ocean, westward of Ireland, are very scanty farther north, toward the parallel of 60°.

With the lapse of years the Ocean Weather Ships will provide hundreds, and even thousands, of observations taken within two restricted areas, and these, it is hoped, will when analysed provide results of considerable interest. It would be possible, for example, to find out whether the flow of current varies appreciably in successive individual years, or over periods of years. At present hardly any information on this point is available for any part of the oceans.

It is not to be expected that much new information can be obtained for the period up to March, 1950, which represents little more than two years of work at each station. One point of considerable interest has however emerged. At JIG the vector mean current for November, 1947, to July, 1948, is N 55°E, 7·3 miles per day, based on a total of 126 observations, while for the year 1949 it is N 67°E, 2·9 miles per day, based on 194 observations. Thus the direction is fairly constant, but the rate is not, and this direction agrees with the general direction of current in this region shown in the atlas. On the other hand, the vector mean current at ITEM is not in accordance with what we should expect. ITEM lies in or near the region where a branch of the North Atlantic Current is supposed to originate, flowing northward and then north-westward, to pass up the west coast of Iceland.

The existence of this current, known as the Irminger Current, is well-established in the region of Iceland, the west coast of which it keeps ice-free throughout the year by its relative warmth. The travel of warm water northward or north-westward can also be traced in M.O.483, *Monthly Meteorological Charts of the Atlantic Ocean*, by an upward looping of the isotherms during most months of the year. It is therefore surprising to find that the current observations at ITEM show no trace of a northerly trend in the long run, though with the general variability, individual northerly currents are not uncommon.

The vector means at ITEM are as follows: S 72°E, 3·5 miles per day for the year 1948, and S 70°E, 7·3 miles per day for the year 1949. The direction, which is constant, is therefore neither in the direction of the Irminger Current nor of the North Atlantic Current, but is a new and hitherto unsuspected one. This will require confirmation in future years before it can be accepted as fact. The direction of the predominant current for the same periods is also between south and east. If the south-easterly direction is confirmed it would seem that the Irminger Current must branch off farther to the westward, which is more difficult to reconcile with the general picture of currents in the northern part of the ocean and with the north-westerly flow past the south-west coast of Iceland.

As was to be expected, the variability of the current shown at both stations is very great, and at either one there is in most cases a marked difference in direction, rate, or both, between the current in successive months and also between the currents in the same month of the two or three years available. This applies both to the vector means and the predominant currents. There are a few exceptions. The direction, but not the rate, of the vector mean current is constant during the month of April at both stations. The values are as follows: ITEM, 1948, S 63°E, 1949, S 62°E; JIG, 1948, N 78°E, 1949, N 80°E. One or two similar instances occur in the case of predominant current, at each station, but not for the same month at both stations.

The best idea of the average rates of the actual currents experienced can be got from the rates of the predominant currents. The highest average monthly rate in miles per day at ITEM was 20, in October, 1948; the lowest 3, in February, 1949. The corresponding figures for JIG are 25 in July, 1948, and 4 in November, 1949.

When a sufficient number of years' observations have been accumulated, an investigation into the relationship between wind, sea temperature and ocean current might be undertaken.

Institute of Navigation

The Annual General Meeting of the Institute of Navigation for the year 1951 was held at the Royal Geographical Society on 19th October, 1951. The retiring President, Sir Robert Watson-Watt, in his address chose as a subject, " Navigation and the Shipping Industry ". He illustrated with some rather impressive figures the great part that the British shipping industry plays not only in our own economics but also from the point of view of world trade generally.

He stressed the contribution that science could make towards solving problems concerning the safety, speed and economy of ships. Work as is done by the British Shipbuilding Research Association into such questions as hull design, reduction of skin friction and improved anti-fouling treatment, played a great part in this important problem. Sir Robert emphasised the enormous influence which meteorological factors have upon the operation of ships; for example, the effect of the relative wind upon fuel consumption and behaviour of the ship generally and how it can, in certain circumstances, be to some extent overcome by streamlining. He emphasised that the meteorologist could do quite a lot in the provision of

adequate and accurate weather information for shipping and that the master of a ship, by intelligently using weather forecasts and other weather information, could tend to operate his ship more efficiently by taking advantage of favourable winds and easing his ship down in heavy weather. There was no doubt about the significance of ocean currents as far as navigation was concerned and there was a real need for more accurate research to be made into the movements of the surface waters in all oceans.

As far as position fixing was concerned, Sir Robert stressed the important part that electronics now played in that they enabled the navigator to fix his ship with reasonable accuracy, irrespective of weather conditions.

The Institute of Navigation has recently instituted a gold medal for " the outstanding contribution to navigation or the outstanding navigational achievement of the year ". An illustration of the emblem appearing on the medal is shown below. On the completion of the President's address, the first gold medal, for the year 1950–51, was presented to Mr. H. Pritchard for valuable contributions to navigation in the field of airborne navigation equipment.

The Institute also issues a bronze medal each year for the best paper to be published during the year in the Institute's *Journal*. It was decided that bronze medals should be presented for the best paper in each volume of the *Journal* since its institution, and three of these medals were therefore presented:

Vol. 1. Mr. R. F. Hansford: " The development of shipborne navigational radar ".

Vol. 2. Mr. C. S. Durst and Mr. N. E. Davis: " Jet streams and their importance to air navigation ".

Vol. 3. Captain F. J. Wylie, R.N. (Retd.): " Radar and the rule of the road at sea ".

Fellowships of the Institute were awarded to the following members:

E. L. T. Barton, O.B.E., Prof. A. J. Bastien, Capt. J. H. Clough-Smith, Capt W. H. Coombs, C.B.E., Group-Capt. R. J. Cooper, M. Dans, Capt. W. Denne, W. A. W. Fox, Cdr. C. E. N. Frankcom, R.N.R., Instructor Rear-Admiral Sir Arthur Hall, K.B.E., C.B., Capt. (E.) J. H. Illingworth, R.N., Capt. A. C. Loraine, Air Commodore J. W. F. Merer, C.B., Capt. R. Oliver, R.N., Capt. W. A. Pearson, J.P., Capt. E. M. Robb, Cdr. G. C. Steele, V.C., R.N. (Retd.), Prof. F. J. M. Stratton, F.R.S., Capt. J. C. Taylor, G. H. Trow, D.F.C., and J. E. D. Williams.

The new President of the Institute is Rear-Admiral A. Day, C.B., C.B.E., D.S.O., R.N., Hydrographer of the Navy.

The Emblem on the Medal of the Institute of Navigation

The Arctic tern and the pair of dividers are intended to symbolise the art and science of navigation. As can be gathered from the accompanying description of its powers of migration, the choice of the Arctic tern is singularly appropriate.

The ARCTIC TERN (*Sterna macrura*) has a circumpolar distribution and nests in the far north, with its breeding range extending southwards as far as the British Isles. During the northern winter those from the North Atlantic Arctic areas fly southwards to Antarctic seas. This species has a latitudinal migration range of some 11,000 miles, which is one of the largest known. Furthermore, most of the routes followed are over the open ocean, out of sight of any landmarks. There is also observational evidence, supported by a few ringing records, to show that Arctic terns bred on the eastern side of North America commonly cross the Atlantic to the coasts of Europe and Africa. Birds which fly from Arctic to Antarctic, spending the summer in each, are unique in the amount of daylight which they enjoy during the year. They also possess strongly developed powers of orientation which enable them to return annually to the same nesting site after this immense migration. The mechanism of this power is still quite unknown.

Royal Meteorological Society

At a recent meeting of the Royal Meteorological Society two related papers of maritime interest were read by Mr. J. M. Craddock of the Forecasting Research Division, Meteorological Office. The first paper, which concerns the modification of continental polar air over Hudson Bay, had been written by Mr. Burbidge of the Meteorological Service of Canada. It describes how physical properties of such air are modified during its passage across Hudson Bay and emphasises that there is considerable evidence that the whole of this bay is frozen over in winter-time. The extent of this freezing over was evident not only from the temperature readings but also from direct air reconnaissance. It is interesting to note that in the United States Ice Atlas* it is inferred that the ice cover over Hudson Bay in winter is by no means complete, whereas in the German Ice Atlas† the indication is given that there is considerable ice over the whole of this Bay. The paper shows that in a normal year ice forms in the Bay in November with a rapid increase in amount and depth during December, and that from January to April the Bay is practically covered with pack-ice. The ice begins to melt in May and decreases rapidly in June. The mean air temperature in February is −17°F at Churchill on the western side of the Bay and −18°F at Port Harrison on the eastern side of the Bay, whereas in July it is 54°F at Churchill and only 47°F at Port Harrison.

The paper goes on to say that in mid-winter the frozen surface of Hudson Bay makes all of northern Canada a uniform snow and ice surface so that the whole area is a source region for continental polar air masses. Thus the presence of the ice cover on the water in winter tends to insulate the water from the overlying air, and instead of warming the air causes it to get colder during its passage across the Bay. In summer, when the water surface is unfrozen and the air mass is initially somewhat warm, the modifying effect of the water is again to cool the air on its passage across the Bay. It is only in November and December—before the ice has properly formed over the Bay—that the water has any warming effect on the air and that the temperature at Port Harrison is warmer than that at Churchill.

The second paper, entitled "The warming of Arctic air masses over the eastern North Atlantic", was written by Mr. Craddock himself, and although not directly related to the earlier paper, concerns a similar subject, i.e. modification of air masses during their passage over a relatively large extent of water. In making his investigation Mr. Craddock ingeniously related upper-air observations both at Iceland and in the United Kingdom and considered the extent to which the temperatures of the different layers of the relevant air masses had been modified during the course of their journey from Iceland to England. The paper quite

**Ice Atlas of the Northern Hemisphere.* Hydrographic Office, Washington, 1946.

†*Monatskarten der Eisverhaltnisse im Nordatlantischen Ozean.* Deutschen Seewarte, Hamburg, 1940.

clearly shows that these cold air masses, after leaving Iceland, do receive considerable quantities of heat and water vapour from the sea. Thus, between 18th and 19th January, 1945, the changes in temperature observed between Reykjavik and Liverpool were an increase in 24 hours of 23°F at the 1,000 mb. level (sea level); 26°F at the 800 mb. level (6,400 ft.) and 7°F at the 550 mb. level (16,000 ft.). The paper demonstrates that the rate of heat transformed is rather closely connected with the difference between sea temperature and surface temperature of the air mass itself. It is, one supposes, fairly well known that air masses do become modified in some way or other during their passage over such water surfaces even if it is only because they pick up moisture during their sojourn over the water, but Mr. Craddock showed that it is a little difficult to understand the mechanics of the process. After discussing the different physical processes which might perhaps account for the temperature increases, the author concludes that " the hypothesis, that when a cold air mass moves over warm sea it gains heat and moisture mainly as a result of intense evaporation from the sea surface, seems to accord with the facts ".

Mr. Craddock's paper demonstrates the need for research into this important question of the heat exchange of ocean and atmosphere, a problem which may well lead to a better understanding of many of the world's meteorological problems.

C. E. N. F.

Book Review

Meteorology with Marine Applications. By W. L. Donn. 9½ in. × 6½ in. pp. xix + 465. *Illus.* McGraw Hill Book Company, Inc. Second Edition, 1951.

When the science of meteorology was in its infancy during the latter half of the last century, the stimulus which it received and which so largely contributed to the progressive development and advances which have led up to the highly complex and specialised science which exists today, arose almost entirely from the needs of the mariner. In recent years, however, there has been a natural shift of emphasis toward the air and the needs of aircraft navigation. The large number of books which have been written with a strong bias toward aviation meteorology have excluded other important aspects. It is therefore with relief and satisfaction that this journal has the pleasure to review a book that has been produced for the benefit of the seaman, and which has been written in a pleasant, readable style, yet conveys the essential facts and theories of marine meteorology in a language he can easily understand.

The significant role of marine meteorology was expounded by Maury during the middle of last century in his *Explanations and Sailing Directions.* We may quote him from Chapter 9 of the book under review: " When we travel out on the oceans, and get beyond the influence of the land upon the winds we find ourselves in a field particularly favourable for studying the general laws of atmospheric circulation. Here, beyond the reach of the great equatorial and polar currents of the sea, there are no unduly heated land surfaces, no mountain ranges, or other obstructions to the circulation of the atmosphere—nothing to disturb it in its natural courses. The sea, therefore, is the field for observing the operations of the general laws which govern the movements of the great aerial ocean. Observations on land will enable us to discover the exceptions. But from the sea we get the rule. Each valley, every mountain range and local district, may be said to have its own peculiar system of calms, winds, rains and droughts. But not so the surface of the broad ocean; over it the agents which are at work are of a uniform character."

The book is divided into 17 chapters covering the chief features of the subject, such as heat and temperature, humidity, atmospheric equilibrium, condensation and precipitation, clouds and thunderstorms, atmospheric pressure, winds and wind circulation, air masses and fronts and the development and structure of

cyclones. A chapter is rightly devoted to tropical storms, a knowledge of which is highly important for safe marine navigation. The book includes a chapter on optical features of the atmosphere. A final chapter on " the oceans " brings together a large amount of interesting information in a small space; thus an even balance is obtained by incorporating a little of the closely allied science of oceanography into the work. Important and instructive is a chapter on " weather coding and notation ", in which the complete ships' international reporting code is given and described in detail. This chapter is followed later by one on weather analysis and interpretation. It is shown in the latter how coded weather reports received by radio aboard ships may be used to plot synoptic charts at sea, and how these charts may be analysed and interpreted in an elementary way to provide the ship-master with valuable information about the winds and weather which may be expected for some hours ahead along the ship's course.

It should be mentioned that the American definition of sleet on page 68 (frozen rain) differs from the British, which defines sleet as a mixture of rain and snow. It is unfortunate that the book is marred by a number of errors and ambiguities. Thus on page 28 it is stated: " The less the air, the less the heat that can be held in the air and the lower the temperature falls ". This may mislead the reader in his attempt to understand the decrease of temperature with height. For example, the temperature of the very rare air at some levels of the upper atmosphere has been proved experimentally to be much higher than at the surface, owing to increased absorption of solar radiation by certain atmospheric constituents, such as ozone, which make up a greater proportion of the air at those levels.

On page 147 it is said: " Then centrifugal force begins to operate and deflects the winds still farther from the direction of the gradient, for this force acts opposite to the pressure gradient ". Centrifugal force only acts in opposition to the gradient when the circulation is cyclonic.

In the heading to the cloud forms on page 256, " Table XX, 13–15 " should read " Table XX, 10–13 ". Also the cloud symbols and photographs on pages 256 to 260g are in the pre-1949 code and are therefore out of date.

A number of errors of implication or of statement have been noted in Chapter 16 (Optical Features of the Atmosphere) and Chapter 17 (The Oceans) but space will not permit of their full presentation here. The following are quoted.

Page 365. The implication that halos of only two radii, 22° and 46°, have been observed is erroneous. Even if the use of the name " halo " is confined to rings centred on the sun, a number of halos of other radii have been seen, though they are rare.

Page 367, under rainbows. No mention is made of the commonly observed supernumerary bows in contact with the under-side of the primary bow, although the very rare tertiary bow is referred to.

Page 387. There is an error near the bottom of the page, the temperature of maximum density of water given (39°F) is that of fresh, not sea, water. For sea water of average salinity the density continues to increase until freezing occurs.

Page 390. The statement that the maximum length of icebergs is a quarter of a mile is misleading, since it is not said that this refers only to Arctic bergs. Antarctic bergs are mentioned later without any reference to the huge dimensions of some of the tabular bergs; the longest authentically measured was 90 miles long.

Some of the statements about currents and their nomenclature in pages 404 to 406 are open to criticism. The Gulf Stream is not so unique in constancy and strength in relation to other ocean currents as is represented. The author calls the south-eastward recurvature of the Brazil Current the "South-east Trade Drift"; this is incorrect, since the Benguela Current is the South-east Trade Drift of the South Atlantic Ocean. The statement that the cold Labrador Current originates in Davis Strait is misleading; the actual current is the most southerly part of the emergent current of the Arctic Ocean, which begins under the name of the East Greenland Current, subsequent parts being called the West Greenland Current

the Baffin Land Current and, from Davis Strait southward, the Labrador Current.

The book is very well illustrated with photographs and diagrams and should be an asset to all mariners who desire to know the basic principles of modern marine meteorology.

A. H. G. AND E. W. B.

Southern Ice Reports

During the year 1951

Date	Position		Description
	Lat.	Long.	
	° ′	° ′	
	APRIL		
26	39 15S	55 45W	Large bergs.
	JUNE		
	R.R.S. *Discovery II*		
10	63 06S	150 10W	1 growler.
	63 24S	149 10W	1 growler.
	63 40S	148 20W	Radar target.
	63 43S	148 10W	2 growlers.
	63 56S	147 28W	2 medium bergs.
11	64 17S	146 20W	1 medium tabular berg, 2 medium bergs, 2 large bergy bits, occasional brash and growlers.
	64 43S	143 50W	1 large tabular berg, 6 bergy bits. Ice just forming on surface, 1 sq. mile of ice crystals.
	65 13S	143 28W	2 medium bergs, sea covered with ice crystals.
	65 21S	143 05W	Medium tabular berg.
12	65 25S	142 50W	Berg observed by radar. Passing through large patches of sea freezing with large ice crystals.
	66 06S	140 45W	Young pancake ice, 2 medium bergs.

Date	Position		Description
	Lat.	Long.	
	° ′	° ′	
	JUNE		
	R.R.S. *Discovery II*		
12	66 01S	140 02W	2 medium bergs; pancakes becoming thicker.
	65 57S	139 18W	2 medium bergs; pancakes becoming thin.
	65 50S	138 40W	2 radar bergs, 1 growler, sea covered with pancake ice.
	65 50S	137 56W	4 bergs; pancakes increased in size, 2 ft. to 15 ft. across.
13	65 02S	136 58W	3 small bergs; very young pancake ice.
	65 02S	136 58W	Several bergs by radar; ice crystals forming on sea surface.
	64 34S	134 34W	2 bergs and numerous pieces.
17	61 41S	108 32W	1 isolated berg, 150 ft. long, 50 ft. high.
18	61 09S	101 45W	Pinnacled berg 70 ft. high.
24	63 52S	77 13W	Heavy pancake ice.
	63 27S	76 33W	North-bound vessel through last streaky patch of slush and young pancake ice

May. No reports received.

Reports of Southern Ice for April, May and June, 1950, will be found in *The Marine Observer*, Vol. XXI No. 152, page 98.

Notices to Marine Observers

Postal Arrangements

The quarterly numbers of *The Marine Observer* are published on the last Wednesdays of December, March, June and September.

The Marine Observer is addressed to the Captain, S.S./M.V. ....., c/o the owners, and captains are requested to make their own arrangements for forwarding.

Ship-owners, Marine Superintendents and all concerned in the despatch of mails to ships are asked to kindly facilitate the despatch and delivery of mail received at their offices from the Meteorological Office and "Air Publications and Forms Stores" to their ships abroad. Addressed to the captains of ships, this contains information required for the conduct of meteorological work at sea, and is most effective if received by the captains at the earliest possible date.

"The Marine Observer"

Captains of observing ships are requested to ensure that all officers who participate in the voluntary meteorological work carried out by the ship have access to *The Marine Observer*.

Ice Observation

Drifting ice, derelicts and other floating dangers to navigation are reported by all means of communication at the disposal of the master.

See Chapter 12, pages 96–98 of the *Marine Observer's Handbook*, Seventh Edition.

It is also desirable that more detailed information than can be given in a TTT wireless message should be available to the Meteorological Office for the purpose of research, and for Admiralty Charts and Sailing Directions.

Marine observers will greatly assist by noting the conditions of ice, either drifting or fast, in the pages provided at the end of the logbook (Form 911), or on Form 912, which may be supplied to the captain of any British ship on application to a Port Meteorological Officer or Merchant Navy Agent.

Observing ships using the Trans-North Atlantic tracks are requested to record not only when ice is encountered, but also when they have passed through the ice region during the ice season without encountering ice. In this case a " nil " report should be returned, since it is desirable as far as possible to determine when tracks have been clear of ice.

Indicator " OBS " in Radio Weather Messages

The attention of marine observers and particularly of radio officers in observing ships is drawn to the necessity of strict adherence to the use of the indicator—" OBS "—preceding the telegraphic address to which the radio weather message is transmitted. Failure to comply with this regulation leads to considerable delay in the clearance of the weather messages.

Address and Despatch of Radio Weather Messages

Masters of observing ships are asked to draw the attention of their observing officers and radio officers to the fact that radio weather messages should be:

(*a*) addressed to the appropriate address in whatever area the ship happens to be:

(*b*) transmitted through one of the radio stations specified for the reception of such messages in that area (see Part IV of *The Marine Observer's Guide* or *Admiralty List of Radio Signals*, Vol. III. Part A).

While ships which are unable to comply with these instructions naturally wish to clear their radio weather messages, considerable inconvenience, embarrassment and financial liability has been caused in the past by such messages being sent by means other than those detailed.

It may happen that a Meteorological Service requests special messages to be made for a short while for some special purpose. Only when a specific request is made by a Meteorological Service should any departure from the rules be considered.

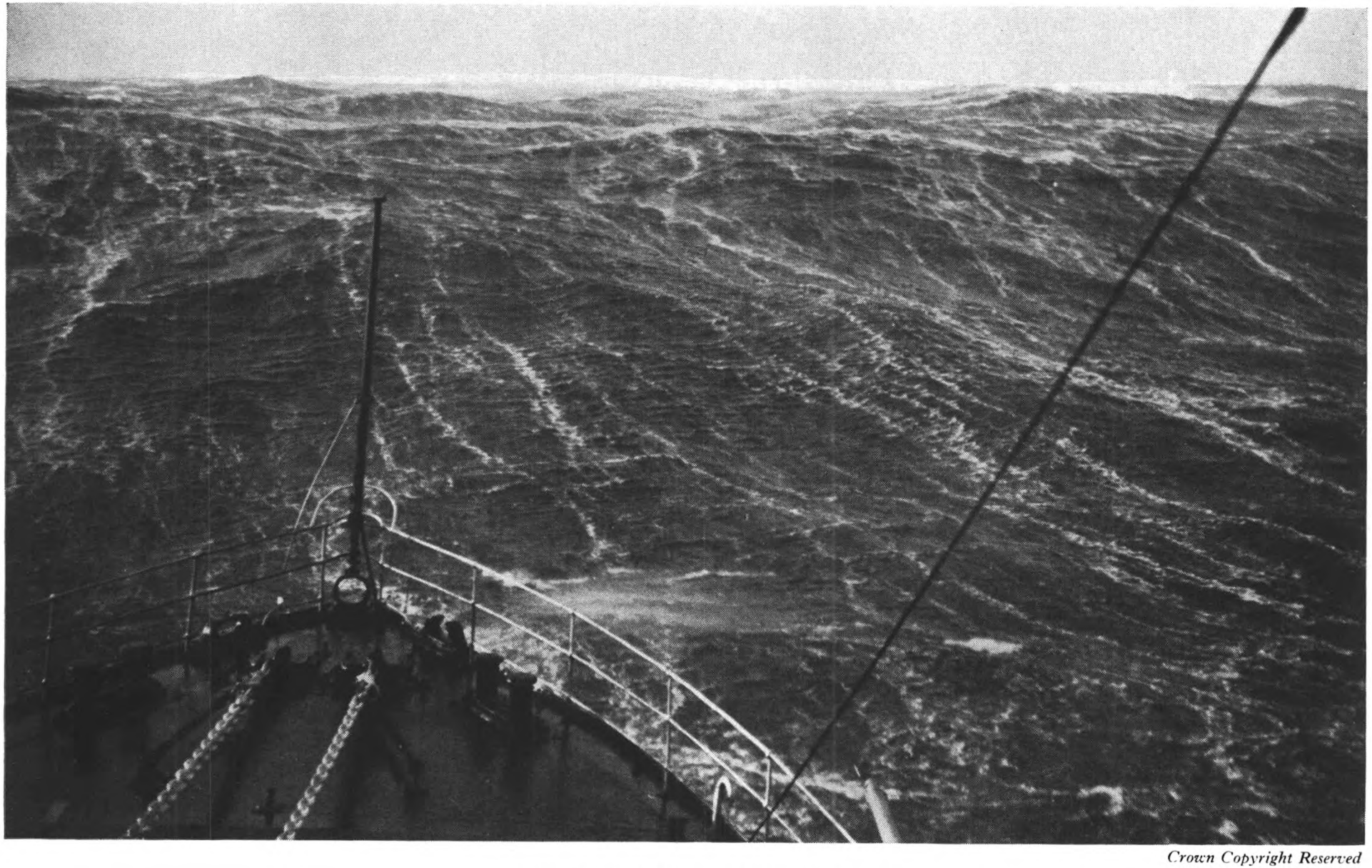
WATERSPOUTS IN THE TYRRHENIAN SEA

The photographs opposite were taken from an aircraft at 600 ft. at 1427 G.M.T. on 3rd October, 1943, and are viewed from a distance of about one mile. The sky was overcast to the east, 4-eighths stratocumulus to the west. The weather was calm but the wind freshened to 15 knots from 335° at this point. Two spouts appeared to be stationary and two more were forming; a large area of water was disturbed.

Another waterspout, the photograph of which is not reproduced, was observed two days later at 0720 G.M.T. The wind was 8 knots from 320° increasing in squalls. No movement of the spout was observed. It formed in five minutes from an area of extremely turbulent water, and developed a pronounced kink after ten minutes. Its total life is not known.

To face page 101

WATERSPOUTS IN THE TYRRHENIAN SEA



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A HEAVY SEA, NORTH ATLANTIC OCEAN

This photograph was taken on board one of the British Ocean Weather Ships. From the appearance of the streaks of foam lying in the direction of the wind it is estimated that the wind at the time was about force 8. The photograph shows the little ripples formed parallel to the main wave crests. These are produced on the wave surfaces by transitory gusts and eddies in places where the main waves give some shelter from the full force of the general wind.

Meteorology for Aviators

By R. C. SUTCLIFFE, Ph.D.

★

THIS volume aims to present in a compact form the aspects of meteorology important in aviation. The pilot of average keenness who wishes to make himself sufficiently a master of the subject for success and efficiency in his profession will find Dr. Sutcliffe's book very useful, as it covers the necessary field with the proper perspective. It is of particular interest to those who have neither the time nor always the inclination to study the whole literature of meteorological science, and who may not have the basic scientific training necessary to follow the presentation in the more technical publications.

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